Montana
Spatial Analysis Project

Montana Department of Natural Resources and Conservation

December 2006

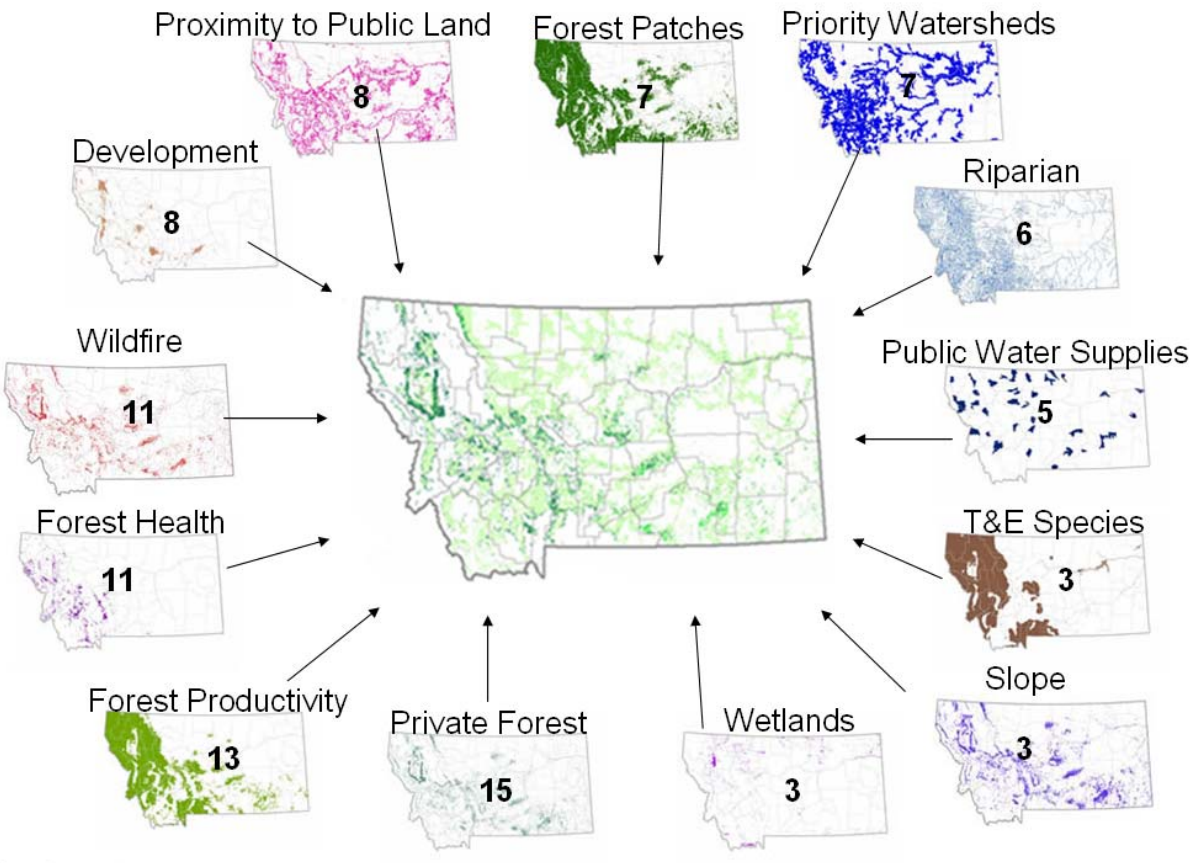


Table of Contents

Executive Summary

Montana Department of Natural Resources and Conservation (DNRC) conducted an assessment of critical private forestland in Montana in 2006. This state-wide assessment was accomplished using geographic information system (GIS) analytic techniques and involved developing three spatial layers—Forest Resource Richness, Forest Resource Threat, and Critical Private Forestland. Results of the analysis will be used to direct the future education and technical assistance activities and may be used to demonstrate the value of forests and forestry on the regional economy, environmental health, and quality of life. This analysis provides insight where future stewardship education and technical assistance opportunities may be most beneficial. It also captures where past activity (i.e. forest Stewardship management plans) has occurred. The project began in July, 2006, and ended in November, with approval by the Montana Forest Stewardship Steering Committee (MFSSC). A subcommittee of this group met several times with the consultant and DNRC staff and made final adjustments in the model weighting and evaluated results throughout the state.

Montana has significant public land acres, primarily in larger contiguous blocks of National Forests in Western Montana, and in some blocks, but primarily scattered sections of Bureau of Land Management lands in Eastern Montana. Approximately 20 percent of the total acreage in Montana is west of the Continental Divide and 80 percent is east of the divide. This geographic split, coupled with the predominant pattern of public lands and industrial forest lands (which were excluded from this analysis) had a large influence on the acreage distribution of the ordinal classification (high, medium and low stewardship potential) applied to Montana SAP. Non forested lands that were still judged as having stewardship potential on critical private lands dominated the total acreage of analysis.

"Stewardship potential" in Montana is defined by NIPF acreage that is prioritized for education and technical assistance. The final results for critical forest stewardship potential on critical private lands indicated there were slightly more than 25 million acres of stewardship potential in Montana, with approximately 2.7 million acres holding high potential. About 21 million acres were low potential, primarily currently non-forested lands east of the Continental Divide. Slightly more than 1 million acres of lands with stewardship potential were on currently non-forested lands. In public land survey sections of land with existing stewardship plans on non-industrial forest ownership parcels, 204,553 acres were on high potential areas, and 407,174 were on low potential lands.

Certain areas of Montana forests are undergoing rapid change due primarily to population growth and subsequent expansion from development. This is resulting in a fragmentation of both our forests and forest management potential, which together are weakening the state's competitiveness in the regional and global marketplace.

In addition, it is increasingly difficult to promote sound forest management as non-industrial private forest (NIPF) landowners are steadily increasing in number and their individual ownership parcel size are becoming smaller. This challenge is exacerbated by weak funding, shifting priorities, and greater demands for accountability. Key stakeholders, forest resources, and threats to the resource vary across the state. Because of this variation, information designed to portray the region must be developed with an understanding of the differing pressures within

the region. DNRC does not have a source of information that adequately shows the pattern and distribution of critical forestland. This Assessment provides this understanding and a strong foundation for better forest management decisions. The consumers of the Assessment include DNRC state forestry agencies staff, and USDA Forest Service (USFS) regional and national programs.

The Assessment results in GIS layers and maps showing forest resource richness and threat on a State-wide basis, with enough detail that sub-county assessments are meaningful. The merging of resource richness and resource threat show the distribution of critical (or priority) forestland. Not only do the results of the analysis provide a new way to describe the region's distinctiveness, they can be used to inform policy makers, stakeholders and concerned groups, as well as empower the region to communicate its distinctiveness and better quantify its management challenges. Knowing where the forest resources are, where they are most vulnerable, and where they are most valuable will be indispensable as the DNRC positions itself as the lead stakeholder of forestry issues in the region.

The Assessment can help meet the challenge of diminishing funds and increasing customer base by facilitating strategic outreach. Because there is limited capacity to promote forest management to landowners, it is more effective to focus energy in places where it will provide the highest return. In addition, as Montana develops its strategy for market competitiveness, it will need to know where the opportunities lie to sustain its most valuable and lucrative assets. The state-wide Assessment will be invaluable for the DNRC as it strives to sustain healthy, productive forests, and protect the economic viability of its private forests.

The Assessment analyzes where best to focus forest management resources, and therefore is a perfect complement to the Montana Wildfire Risk Assessment (MWRA), whose output will help focus fire suppression, prevention, and mitigation resources. These two data sets together will empower the region to market its identity more comprehensively.

The resulting output will be useful and relevant at many spatial scales, from regional down to sub-county. As a result, the model outputs will help Montana address critical resource management issues within each state, be it with state and county policy makers or as a tool for agency foresters.

A GIS modeling methodology has already been developed to identify resource richness and resource threat on non-industrial private forestland as part of the Spatial Analysis Project (SAP) of the Forest Stewardship Program. The USFS developed the SAP model primarily to address the efficacy of Forest Stewardship Plans and to promote strategic program delivery. DNRC recognizes additional benefits beyond meeting the standard goals of the project. Spatial analysis can assist states in managing their Private Forest Programs and can help as an analytical tool when addressing forest policy issues. A national objective was to have a country wide analysis completed state by state. Participating states are being asked to use a given set of 11 data layer themes and to follow an establish set of procedures and standards for displaying results. States have the freedom to add additional GIS data layers needed to describe local conditions, and to weight each data layer to best reflect is level of importance. Montana used one additional layer "Forest Productivity." The standard data layers themes include: Riparian Corridors, Forest Patches, Public Water Supply Areas, Priority Watersheds, Threatened & Endangered

Species, Proximity to Public Forestlands, Wetlands, Topographic, Wildfire Risk, Insect and Disease Risks, and Development Risk.

Montana DNRC worked with the MFSSC in establishing weighting factors for each data layer. These data layers and weighting factors focus on NIPF issues. The analysis provides a priority value for each 30 meter by 30 meter piece of non-industrial private forest land across the state. These cells were then grouped into high, medium, or low categories. The Montana weighting strategy included differences from the National model, and differences with other states that have completed their SAP analysis. Tree farms, for instance were considered in Colorado, but were not applied in Montana.

Stewardship Analysis Project (SAP) Introduction, Purpose & Background

USDA-Forest Service and state forestry agencies have a long standing partnership that began in the late 1940s promoting the protection and improvement of private forestland. Current efforts are defined in the Cooperative Forestry Assistance Act of 1978 and create the Forest Stewardship Program (FSP) of 1990 as the primary tool for assisting family and other non-industrial forest landowners. The focus of this Spatial Analysis project is to assist the Forest Service and state forestry agencies in the administering and monitoring of FSP. Montana DNRC fully supports a national spatial analysis effort.

The FSP has been very successful as a national program in promoting sustainable forest management. Comparing today's national and state strategies for assisting NIPF landowners with those of 1990 when FSP was first introduced clearly demonstrates the evolution of the program. Multi-resource management planning is now an accepted standard. It is by far the exception, that timber production is the primary goal when considering forest planning. Efforts such as spatial analysis strengthen the FSP and other assistance efforts, and benefit landowners, states, and the nation.

NIPF landowners are defined as private individuals, group association, corporation, Indian tribe or other private legal entity. These lands may have existing forest cover or may be suitable for growing trees. Forestland was identified using the National Land Cover Database (NLCD)

The USDA-Forest Service Northeast Area, in partnership with four state forestry agencies, developed a GIS process for mapping lands eligible for the FSP, prioritizing them, and overlaying these lands with existing forest stewardship plans. After these four states completed their spatial analysis project in 2003-2004, the Forest Service offered incentive grants to several Western states in order to complete spatial analysis projects. In 2005 Montana received a grant to initiate the analysis on a statewide basis.

The Initial scoping of the SAP process was coordinated through the Montana Forest Stewardship Steering Committee (MFSSC). For the purpose of this exercise, Forest Stewardship potential was defined as NIPF acreage that would benefit most from education and technical assistance. Through a series of work sessions, 13 overall data sets were selected and individually evaluated for their specific application to the Montana SAP. At several milestones in the analysis process, the group reconvened to assess whether the process was heading in the correct direction. During these discussions there were several modifications made to data set structure and its relation to the overall project. Each of these modifications are covered in individual data set summaries.

SAP Implementation

The SAP will provide Montana with the ability to track and display FSP activities over a statewide landscape now and in the future. Through continual GIS analysis, resource data dealing with multiple issues can be mapped and planned. The Montana FSP will benefit from knowing more about the actual location of stewardship plans across the landscape, and identify potential opportunities where individual landowner planning can address key larger scale resource needs. SAP will also assist regional and national FSP managers to address program effectiveness and public funds accountability.

The FSP Spatial Analysis Project (SAP) is an effort to provide a consistent methodology across the country to evaluate and prioritize natural resource issues, and at the same time offer states the ability to customize collection and analysis of pertinent spatial data. The analysis will provide insight into:

- Important forest lands (rich in natural resources, vulnerable to threat, or both);
- Existing stewardship tracts (properties under management plans); and
- Areas of opportunity to focus future FSP efforts (stewardship potential).

Montana's SAP will also address the following questions, as they relate to the FSP:

- Where are the state's NIPF lands?
- Where are the management plans?
- Where are the state's priority NIPFs (those lands of highest potential to benefit from active forest management)?
- What percentage of existing NIPF management plans are on the state's priority family forest lands?
- Are there opportunities to implement forestry education or technical assistance to increase forest management activities in high priority areas?

With additional GIS data layers, spatial analyses can also be used to:

- Assess program effectiveness in serving state-identified critical resource management needs.
- Relate factors such as completed cost/share practices, landowner activities, and monitoring data to help determine program strategies and effectiveness.
- Establish future practices that can improve effectiveness in addressing priority needs based on landscape scale resource issues.
- Determine the economic, environmental and social importance of NIPFs.
- Provide additional information and clarity when addressing a broad range of forest policy issues.

There are three primary directions that will evolve out of Montana's SAP.

- Development of a historic management plan database and associated geo-referenced map of existing forest stewardship plans. We would like to see statewide Tree Farm plans and conservation easements integrated in the future.
- Assessment of how the state can use the results of these analyses to guide future landowner assistance activities in conjunction with other NIPF programs.
- Recommendations for modifying the future spatial analysis efforts to evolve with the current FSP.

Stewardship Potential Suitability Analysis

The state-wide stewardship suitability analysis is comprised of thirteen common data layers, and an analysis mask. The layers are divided into four categories: forest resource richness, forest resource threats, critical private forest and non-forest land with stewardship potential, and analysis masks.

Forest Resource Richness

- Private forestland
- Forest patches
- Riparian river areas
- Wetlands
- Slope
- Proximity to public lands
- Priority watersheds
- Public water supply
- Threatened and Endangered Species
- Forest Productivity

Forest Resource Threat

- Wildfire risk
- Forest health (Insects and diseases)
- Development level

Critical Private Forestland (all input layers)

- Private forestland
- Forest patches
- Riparian river areas
- Wetlands
- Slope
- Proximity to public lands
- Priority watersheds
- Public water supply
- Threatened and Endangered Species
- Forest Productivity
- Wildfire risk
- Forest health (Insects and diseases)
- Development level

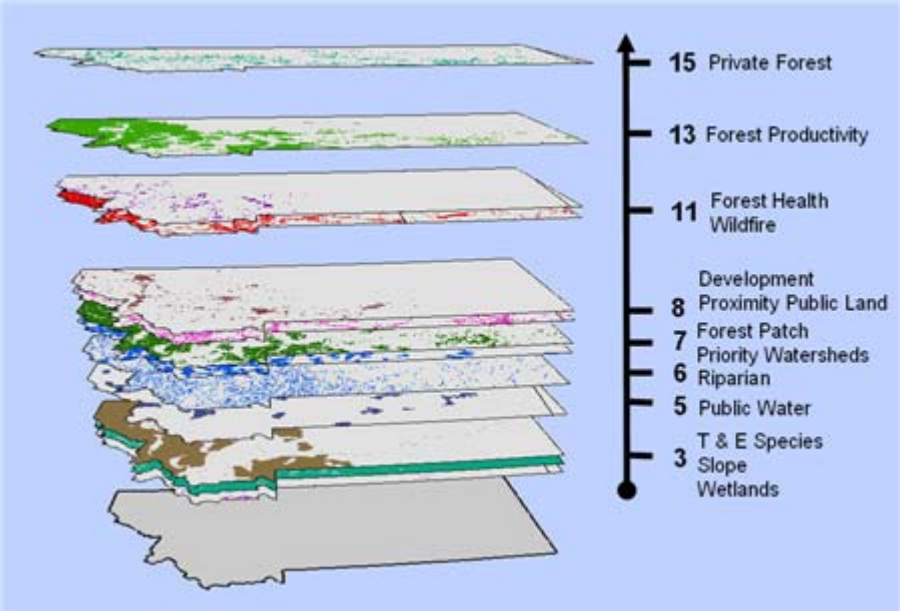
Analysis Masks

- Forest and non-forest land cover
- Public land, private lands and large corporate forest land

Data Layer Development

The thirteen data layers used for this analysis are described in the following section. The weighting scheme for the layers is shown in Figure 1. Twelve of these layers were mandated by the federal SAP requirements. The 13th layer was added within the SAP flexibility scope, to localize the process for Montana. The MFFSC SAP subcommittee ranked the 13 layers based on relative importance for delivering stewardship education and technical assistance.

Figure 1 SAP Data Layers with Weighting



Forest Resource Richness

1. Private Forestland

The private forestland layer was created by combining forest cover with private lands in Montana, as described in detail in the Analysis Masks section of the report. The forest stewardship potential on critical private lands mask was the source for this map layer.

The forest cover used in this project was extracted from the National Land Cover Dataset (NLCD). The 1992 NLCD was derived from early to mid-1990s Landsat 5 Thematic Mapper satellite data and is a 21-class land cover classification scheme applied consistently over the United States. The spatial resolution of the data is 30 meters. NLCD is provided on a state-wide basis. Based on input from the MFSSC subcommittee, the NLCD shrub layer was excluded from the forest classification, unlike the approach that Colorado took in their SAP program.

The forest cover layer was derived by combining four NLCD classes:

- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Woody Wetland

Private lands were derived from the Montana stewardship layers provided by two state agencies, and supplemental corporate forest land ownership provided by DNRC, as described in detail in the Analysis Masks section of the report.

The final input grid included a grid value of 1 for private forestland and a 0 for all public and large corporate lands, with a weighted overlay value of 15 percent.

2. Forest Patches

The forest patches layer was derived from the private forestland layer and the state-wide road grid. The goal of the forest patches layer was to determine a minimum patch size and place emphasis on management of these areas. Roads create discontinuities in forest cover and reduce forest patch size for some wildlife species.

The latest Montana Department of Administration Information Technology Services Division (ITSD) transportation framework dataset was used for road delineation. This is the best compendium of roads and transportation infrastructure in the state, and represents the best available sources from the Montana Department of Transportation (MDT), local counties, Census Tiger files, and the U.S. Forest Service (USFS) road networks. All road classes in the statewide transportation layer were used in the development of this layer.

A road grid, with 30 meter cell size, was created directly from the vector road features in the transportation framework dataset. The road grid was then used as a mask to cut out the forest areas from the private forestland layer. This resulted in a forest patches layer of areas equal to or greater than 100 acres.

Initial specifications set up by the planning committee called for roads to be buffered by type: 100 feet for interstates, 55 feet for state and federal highways, and 38 feet for all other roads. But, because the analysis layers were 30 meter cell grids, it was impossible to use the desired buffers. Buffering the linear roads and then creating grids from the buffer polygons, created undesired breaks in the road corridor continuity. Also, it was impossible to exactly replicate 38 ft., 55 ft., or 100 ft. buffer polygons with 30 meter cells. However, creating a road grid with 30 meter cell size directly from the vector road features maintained the continuity of road corridors and approximated a buffer zone along the roads. The grid representation of a linear feature (i.e. roads) resulted in buffer zones ranging from about 0 to over 120 feet on one side of the linear element, but continuity was maintained when using the FOUR option with the ESRI *regiongroup* routine. Using FOUR prevented cells that only have adjacent corners from being assigned to the same group, so it did not connect forest patches on opposite sides of a road.

Final input grid included a grid value of 1 for forest patches and a 0 for all other areas, with a weighted overlay value of 7 percent.

3. Riparian River Areas

Riparian river areas were identified in the U.S. Geological Survey (USGS) National Hydrography Dataset (NHD). All perennial streams and major rivers in the NHD were buffered by 300 feet on each side. Some stream segments that were coded perennial (such as portions of the Clark Fork River) are composed of network connectivity lines overlaying polygons in the NHD water bodies. These lines assist in maintaining connectivity of the stream routes through those water bodies. These segments that pass through lakes were removed from the perennial stream data. The resulting perennial streams and rivers were buffered by 300 feet, and converted to a grid with grid value = 1 for riparian corridors and 0 or non-riparian areas.

The final input grid included a grid value of 1 for riparian areas and a 0 for all non-riparian lands, with a weighted overlay value of 6 percent.

4. Wetlands

Wetlands were identified in the National Wetland Inventory (NWI) data maintained by the U.S. Fish and Wildlife Service (USFWS). The inventory has only been completed for a portion of Montana. For areas not covered by NWI, the wetlands data from NLCD was used. The features in the NWI were split into riparian and wetlands, and only the wetlands classes were merged, forming this layer (the riparian codes PSSA, PSSB, PSSC, PUSA, PUBG and PUSC were excluded from this layer).

The final input grid included a grid value of 1 for wetlands and a 0 for all other lands, with a weighted overlay value of 3 percent.

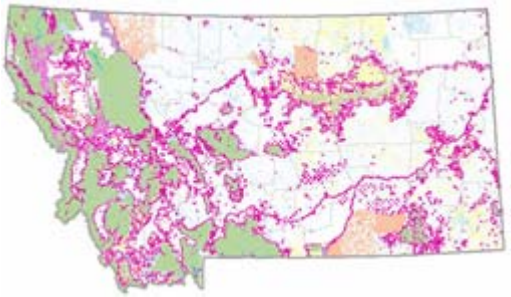
5. Slope

The slope layer was used to highlight ease of operability for forest harvesting operations, which contribute to productive forests more likely to remain forest. Similarly, this layer can be used as an indicator of the site's erodibility. The statewide 30-meter digital elevation models (DEM) from the Montana State Library Natural Resources Information System (NRIS) was used to develop a

topographic slope layer with slopes classified into those ranging from 0 – 40 percent. The forest stewardship potential on critical private forestlands mask was used to select only slope values for the areas that fall within private forest lands.

The final input grid included a grid value of 1 for all lands with slope less than 40 percent on private forestland and a 0 for all other lands, with a weighted overlay value of 3 percent.

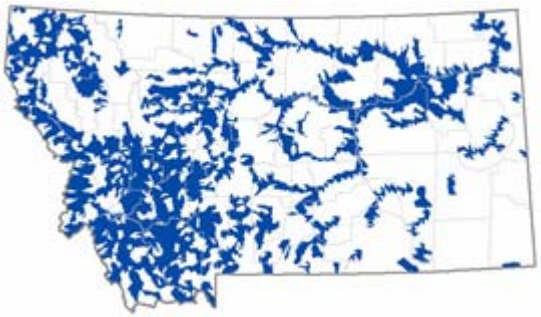
6. Proximity to Public Lands



The proximity to public lands layer was created by combining a ½ mile buffer of public lands of those public lands that were at least 10 percent forested (based on the NLCD forest cover layer). The public lands layer was developed as described in detail in the Analysis Masks section of the report.

The final input grid included a grid value of 1 for all lands in proximity to forested public lands and a 0 for all other lands, with a weighted overlay value of 8 percent.

7. Priority Watersheds



The priority watersheds layer was derived from the U.S. Environmental Protection Agency (EPA) data on impaired water locations. These data are based on the Clean Water Act Section 303(d) lists that show water quality standards impairment or threats to the attainment of beneficial uses or anti-degradation provisions. The 303(d) list includes five categories:

- Category 1: Waters for which all applicable beneficial uses have been assessed and all uses are determined to be fully supported.
- Category 2: Waters for which those beneficial uses that have been assessed are fully supported, but some applicable uses have not been assessed.
- Category 3: Waters for which there is insufficient data to assess the use support of any applicable beneficial use, so no use support determinations have been made.
- Category 4: Waters where one or more beneficial uses have been assessed as being impaired, fully supporting but threatened, all TMDLs are completed but impaired beneficial uses have not yet achieved fully supporting status, or impaired and TMDLs are not required:
- Category 5: Waters where one or more applicable beneficial uses have been assessed as being impaired or threatened, and a TMDL is required to address the factors causing the impairment or threat.

Category 4 or 5 water features were selected as the map source for priority watersheds for the SAP process. The 6th code watershed units (HUC) with an impaired water location were selected as the unit of analysis. These two layers were intersected and the 6th code watersheds with category 4 or 5 impaired waters were selected as priority watersheds.

Both the federal Clean Water Act (CWA) and the Montana Water Quality Act require an ongoing program of water quality assessments and reporting as part of a process intended to protect and improve the quality of rivers, streams, and lakes in the state. The 2006 database update was not yet completed when this SAP analysis was conducted. As a result the data is based on 2004 data, the latest available data set.

Final input grid included a grid value of 1 for priority watersheds and a 0 all other watersheds, with a weighted overlay value of 7 percent.

8. Public Water Supply

The public water supply layer included community surface water intake locations, from the Source Water Protection database maintained by the Source Water Protection Program of the Montana Department of Environmental Quality (DEQ). The 5th code watershed HUCs with a community surface water intake location were selected based on an overlay of the intake points on the GIS watershed layer. Any watershed polygon that had one or more intakes, regardless of type of intake or vulnerability, was selected. This database was maintained to help the Source Water Protection Program track the status and progress in completing Source Water Delineation and Assessment Reports (SWDARs) for every active public water supply in Montana. The GIS layer consists of one or more points for each public water supply that represent spring, well, or surface water intake locations.

Release of this layer to the general public directly or through other agencies or entities was not authorized by DEQ. The data was generalized to broad watershed delineations and the original point locations cannot be identified.

The final input grid included a grid value of 1 for watersheds including public water intake locations a 0 for all other watersheds, with a weighted overlay value of 5 percent.

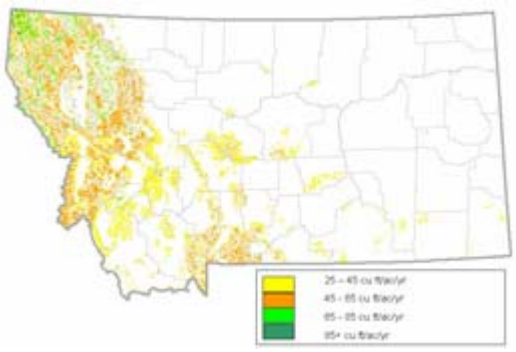
9. Threatened and Endangered Species

Data for the threatened and endangered species layer was obtained from the University of Montana Natural Heritage Program. The information provided by MTNHP is intended for distribution or use only within the requesting department, agency, or business. A generalized composite summary was created of all the data from MTNHP for threatened and endangered species. It cannot be reversed engineered to identify individual species locations.

The final input grid included a grid value of 1 for threatened and endangered species and a 0 for all public and large corporate lands, with a weighted overlay value of 3 percent.

10. Forest Productivity

Several alternatives were considered as the source for forest productivity.



- Landfire rapid assessment potential natural vegetation, representing the vegetation that could be supported on a given site based on the biophysical environment and absent any disturbance. This layer was available for all of Montana, but was designed for national to regional levels of analysis. The Landfire landscape level data was only available for Western Montana.
- SSURGO soils site index, the NRCS 1:24,000 scale detailed mapping included site index information for forest species. This data was used in the Oregon SAP analysis. The SSURGO is almost completed for most of Montana, but in our analysis, the site index values were sporadic in coverage, and appeared to be limited to western Montana. The pilot areas in eastern Montana had null values. We were unable to locate any detailed metadata or explanations in the literature. Dr. Fieldler observed that the site index values listed appeared on the low end in the pilot areas.
- US Forest Service Region 1 Vegetation Mapping Project (-VMAP). This layer is the best source for detailed vegetation mapping for lifeform, tree canopy cover class, tree diameter, and dominance type. The data set, however, only covers the western portion of Montana.
- University of Montana and Montana Department of Revenue potential forest productivity (see below).

After review of the different alternatives using three sample pilot areas in the Flathead, Missoula, and Bull Mountain areas, and expert opinion from Dr Carl Fiedler at the University of Montana, the preferred data source for identifying forest productivity classes was determined to be the University of Montana/Montana Department of Revenue potential forest productivity layer. Although there were limitations of the data and model, it was complete for all of Montana and the SAP area of interest, and was judged to be a more accurate source of forest productivity than the SSURGO data.

The UM model, developed by the Numerical Terradynamic Simulation Group at the University of Montana predicted and mapped potential forest productivity (cubic volume increment at culmination of mean annual increment, CMAI) for all forest land in the state of Montana. The biophysical modeling logic that was used to estimate productivity of forested landscapes primarily used the model Forest-BGC and its progeny Biome-BGC, Tree-BGC, and Fire-BGC. In the BGC (Bio-Geo Chemical) logic, basic growth processes (photosynthesis, transpiration, respiration and carbon allocation are driven directly by climatic events: daily precipitation, solar radiation relative humidity, precipitation and maximum and minimum temperature). The models were combined along with a hill slope hydrologic routing model, TOPMODEL, in a GIS environment for use in calculating ecosystem flux rates at spatial scales ranging from hill slope to regional resolutions. The combined set of models results in a regional hydro-ecological simulation system (RHESSys). The only derivative available from this project is the final

potential forest productivity layer for existing forest lands, derived from Landsat imagery in the 1991. This was the layer used in this analysis.

The method used by Department of Revenue for forest valuation in Montana is currently in revision, and will be replaced in 2007-2008. The new methodology uses a stratified sample of site index conditions based on extensive field plots. It will be beneficial to re-run the SAP analysis once these new data are made available in 2008.

The following productivity classes were used. The non forestland, hardwood stands (cottonwood and aspen), and Department of Revenue defined non-commercial lands (which were lands with less than 15 acres of contiguous forest land) were given a value of 0 and defined as non-forest.

Description	Grid value / weighted overlay value
Class 4: 25 – 45 cu ft/ac/yr	3
Class 5: 45 – 65 cu ft/ac/yr	6
Class 6: 65 – 85 cu ft/ac/yr	12
Class 7: 85+ cu ft/ac/yr	13

Forest Resource Threats

1. Wildfire Risk

The wildfire risk layer used the rapid assessment fire regime condition classes from the National Landfire Program. LANDFIRE Rapid Assessment fire regime condition classes (FRCC) delineate a standardized, interagency index to measure the departure of current conditions from reference conditions. FRCC is defined as a relative measure describing the degree of departure from the reference fire regime. This departure results in changes to one (or more) of the following ecological components: vegetation characteristics (species composition, structural stages, stand age, canopy closure, and mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated disturbances (such as insect and disease mortality, grazing, and drought). FRCC is composed of three classes:

1. FRCC 1 - Within the natural (historical) range of variability ("reference fire regime") of vegetation characteristics; fuel composition; fire frequency, severity and pattern; and other associated disturbances
2. FRCC 2 - Moderate departure from the reference fire regime of vegetation characteristics; fuel composition; fire frequency, severity and pattern; and other associated disturbances
3. FRCC 3 - High departure from the reference fire regime of vegetation characteristics; fuel composition; fire frequency, severity and pattern; and other associated disturbances

Fire regime condition classes 2 and 3 were selected for this analysis. Those areas in condition class 2 and 3 were masked to only include the private forest lands, based on the private forest lands mask described in section 1. All areas in the two wildfire condition classes and on private forest land were given a grid value rating of 1, and all other areas a value of 0. This layer was weighted by a value of 11 percent.

The more detailed landscape level Landfire data would have been preferable as a data source, but it was only available for the area west of the continental divide in Montana. The SAP analysis should be rerun with the landscape level Landfire data for the whole state when it is available (by 2009).

The final input grid included a grid value of 1 for all areas defined with wildfire risk and a 0 for all other lands, with a weighted overlay value of 11 percent.

2. Forest Health (Insects and Diseases)

Data from the forest health risk mapping efforts by the USFS was mapped from 2000 to 2005. Data was originally acquired from the USFS aerial surveys covering multiple years and insect and disease species. This group of layers contains ten individual layers representing the results of annual insect and disease aerial detection survey flights in USDA Forest Service - Region 1 from 2000 to 2005. These surveys cover a large part of the forested areas, including Federal, State, and Tribal lands in Region 1. The layers represent the actual aerial detection surveys, and also the areas that were flown and not flown. The surveys were conducted by the Forest Health Protection Group in the State and Private Forestry Staff, Region 1. Region 1 is within the perimeters of northeastern Washington, northern Idaho, and Montana; and a national grassland in North Dakota and northwestern South Dakota. The purpose of an aerial detection survey was to detect new outbreaks or identify previously undetected outbreaks of forest pests, monitor existing outbreaks, provide timely information for management planning, and provide information for forest health assessments and project plans.

The selected data for the health layer in this SAP analysis consisted of the aerial detection survey flown in 2005 including Douglas-fir beetle, Engelmann Spruce beetle, Mountain Pine beetle, Fir engraver, Western Balsam bark beetle, Spruce budworm, White Pine blister rust, and dwarf mistletoe. Dan Rogers, DNRC SAP coordinator, discussed this layer with forest entomologists and selected the six species to be used in the analysis and determined that only the data from the most recent year would be used in SAP analysis.

The final input grid included a grid value of 1 for presence of selected insects and diseases and a 0 for all other lands, with a weighted overlay value of 11 percent.

3. Development Level

Development level was identified as those areas forecasted to have development of greater than five homes per quarter section by the year 2025. The analysis was conducted by the Sonoran Institute to examine future residential development in 31 of Montana's counties, where the majority of the stewardship plans have been completed (Beaverhead, Big Horn, Broadwater, Carbon, Cascade, Deer Lodge, Flathead, Gallatin, Glacier, Granite, Jefferson, Lake, Lewis and Clark, Liberty, Lincoln, Madison, Meagher, Mineral, Missoula, Park, Pondera, Powell, Ravalli, Sanders, Silver Bow, Stillwater, Sweet Grass, Teton, Toole, Treasure, and Yellowstone). Census block groups were analyzed from the 2000 Census data to determine if there were any additional areas of Montana with increases in residential development predicted in the future. The remaining counties not included in the Sonoran study all showed declining residential growth, so no additional analysis was required in the remaining 25 counties.

The Sonoran dataset includes homes within subdivisions but excludes mobile homes, for which historical location information was not available. The historical data were collected from the Montana Departments of Revenue, and were summarized per Quarter Section according to the Public Land Survey System (PLSS). The tax assessor data are current through 2005. Forecasts of residential development were for 2025. This dataset describes the forecasted locations of homes within subdivisions but excludes mobile homes, for which historical location information was not available. Fifty-five potential explanatory variables were used to analyze the correlates of growth from 1995-2005. These variables describe the study area with respect to natural resources, transportation, services, natural amenities, and past home development, and are consistent with the bio-physical and socio-economic factors identified in the growing body of literature investigating the drivers of human settlement patterns. Examples include suitability for agriculture, travel time to airports, and travel time to national parks.

Data was used with the permission of the Sonoran Institute. The information provided was intended for distribution or use only within the requesting department, agency, or business, and should not be distributed to the public or used for other purposes.

Final input grid included a grid value of 1 for private quarter sections projected to have 5 or more residences by 2025 and a 0 for all other lands, with a weighted overlay value of 8 percent.

Analysis Masks

Several analysis masks were developed for this project. They were used to exclude geographic areas in the analysis, and to define the geographic areas used in final acreage calculations for different categories and classifications of land. The original statement of work stated that "The analysis mask for the Forest Resource Richness and Forest Resource Threat layers will include only open water. The analysis mask for the Critical Private Forestland layer will include urban areas, public land, and open water. For urban areas and open water, NLCD data will be used." The original mask definition in the statement of work was modified by DNRC staff and the subcommittee during the review process, and the final analysis masks were developed as follows:

1. Forest stewardship potential on critical private lands

Excluded areas are public lands and industrial forest company lands, and specific land cover classifications from the NLCD database defined in the project scope of work. The NLCD exclusions included open water, quarries, bare rock and sand, perennial ice and snow, and industrial/urban areas as identified by NLCD (values = 11, 12, 21, 22, 23, 31, and 32).

The land ownership source for the classified forest stewardship potential on critical private lands mask layer was initially extracted from the Information Technology Service Division (ITSD), Montana Department of Administration stewardship geodatabase. This layer was selected as the base for the public/private lands layer in Montana, even though there were gaps in the statewide geodatabase, which was acquired as a work in progress. Gaps in the layer, which primarily occurred in the Flathead Valley and other small portions of western Montana, were filled in with ownership information from the Montana Natural Resource Information System (NRIS) stewardship layer. The rationale for using the ITSD layer was its role as the basis for the Montana cadastral database, and a greater likelihood of maintenance in a timely fashion in the future. It also provided the ability for a closer match to stewardship plan maps. The cadastral was based on BLM Geographic Coordinates database (GCDB). Due to different survey control, this layer can have different ownership lines than the NRIS layer, which is based on 1:100,000 scale corners from USGS quadrangle maps. As a result some slivers were created in the merging process of filling the gaps with the NRIS version of stewardship. Once the public land composite was created, large corporate timber lands, derived from the Plum Creek timber company lands from the stewardship layer, were subsequently merged with the public/private land, and lumped into the "public" category. The same operation was applied to the separate GIS files of other large private timber companies provided by DNRC. This composite resulted in two final mutually exclusive layers used in the analysis, defining all the "public" (public and large corporate forest ownership) and private lands in Montana potentially available for stewardship. The private land mask was subsequently used in all operations, maps and acreage summaries requiring the classified forest stewardship potential on critical private lands mask.

2. Forest stewardship potential on critical private forestlands mask

The forest stewardship potential on critical private lands mask layer, described in the previous section was subsequently overlaid on the existing forestland and forest cover grid to subdivide it into two components, those currently forested and those currently non-forested. The forest cover layer was derived by combining four NLCD classes: deciduous forest, evergreen forest, mixed forest and woody wetlands. The intersection of these two layers including the forest stewardship potential on critical private lands mask layer, and the existing forest layer from NLCD became the forest stewardship potential on critical private forestlands mask.

3. Forest stewardship potential on critical private non-forestlands

This project identified all non-corporate forest private lands as critical to forest stewardship. The forest planning and management of agroforestry applications is part of the national Stewardship Program, but was not applied in Montana. The state's existing forest policies focus on maintaining and improving existing forest lands. Montana has a strong agricultural economic and social base, and converting farm lands to forestland is not an objective of the Montana SAP.

The derivation of this layer included all lands in the forest stewardship potential on critical private lands mask layer that were not included in the stewardship potential on critical private forestlands mask along with the areas of development and projected development, defined by the development layer, were also removed. The private forestlands mask and the private non-forestlands mask layers are mutually exclusive.

4. Forest resource richness and forest resource threats

The DNRC staff and subcommittee modified the mask criteria for resource richness and resource threats to only include those lands within the forest stewardship potential on critical private lands mask layer, instead of the original, less exclusive criteria of all lands except open water.

Weighting

To produce the composite layers, each input layer was given a weight according to their relative importance. The MFCCS committee derived the weighting scheme for the individual suitability layers based on relative importance for delivering stewardship education and technical assistance. Once all data layers were assigned a percentage, the percentages were converted to weighting values, that is 10 percent became a value of 10 and the sum of the maximum points for all 13 layers equaled 100. With the exception of the forest productivity, which included variable points based on the productivity category, all of the other layers were binary presence/absence map layers and cored the full weighted score for the layer for map areas mapped present and scored 0 for areas mapped as absent.

As Oregon noted in their assessment, adding additional layers to the analysis reduced the sensitivity of weighting. A total of 64 percent of the weighting criteria in Montana relied on or were influenced by existing forest cover. With the geographic distribution of lands and the ordinal measurement scale, any layer that had broad spatial distribution in eastern Montana (such as the operability criteria of slopes less than 40 percent) initially gave a given unit of analysis some score greater than 0. After the MFCCS subcommittee reviewed the results of the preliminary mapping they revised the analysis methodology and applied additional forest related pre-condition criteria to the wildfire risk, slope, and proximity to public lands layers.

Data layer weights:

- Private forestland 15%
- Forest productivity 13% maximum
  - Class 4: 3%
  - Class 5: 6%
  - Class 6: 12%
  - Class 7: 13%
- Forest health (Insects and diseases) 11%
- Wildfire risk 11%
- Development level 8%
- Proximity to public lands 8%
- Forest patches 7%
- Priority watersheds 7%
- Riparian river areas 6%
- Public water supply 5%

- Threatened and Endangered Species 3%
- Slope 3%
- Wetlands 3%

Overlay Analysis

The GIS data representing each of the layers was converted to the ESRI grid format with a cell size of 30 meters, an area representing approximately one-quarter acre. Each cell of the grid for each factor was converted to a value of either 0 or 1 (except for forest productivity). For example, all the 30-meter grid cells that fall within the riparian river buffers were coded as "1," while all cells outside the riparian buffers were coded as "0" in that layer. Each grid cell was multiplied by its weighted value, so that cells coded as "1" took on the weighted value while all "0" cells retained a value of 0. The final result grid contained cells whose values equaled the sum of the values in the same location (on the same quarter-acre) from all included layers in each composite layer.

The ESRI Spatial Analyst extension allowed for the specification of an analysis mask. The analysis mask described above was used to exclude areas that did not meet eligibility requirements for inclusion in the Forest Stewardship Program.

The ESRI Modelbuilder functionality was used to model and run each of the analysis steps in compiling the SAP overlay analysis. Three models were developed. These are shown in figures Figure 2 to Figure 4. Full documentation and GIS metadata are provided in Appendix B.

Figure 2 SAP Model Overlay Analysis

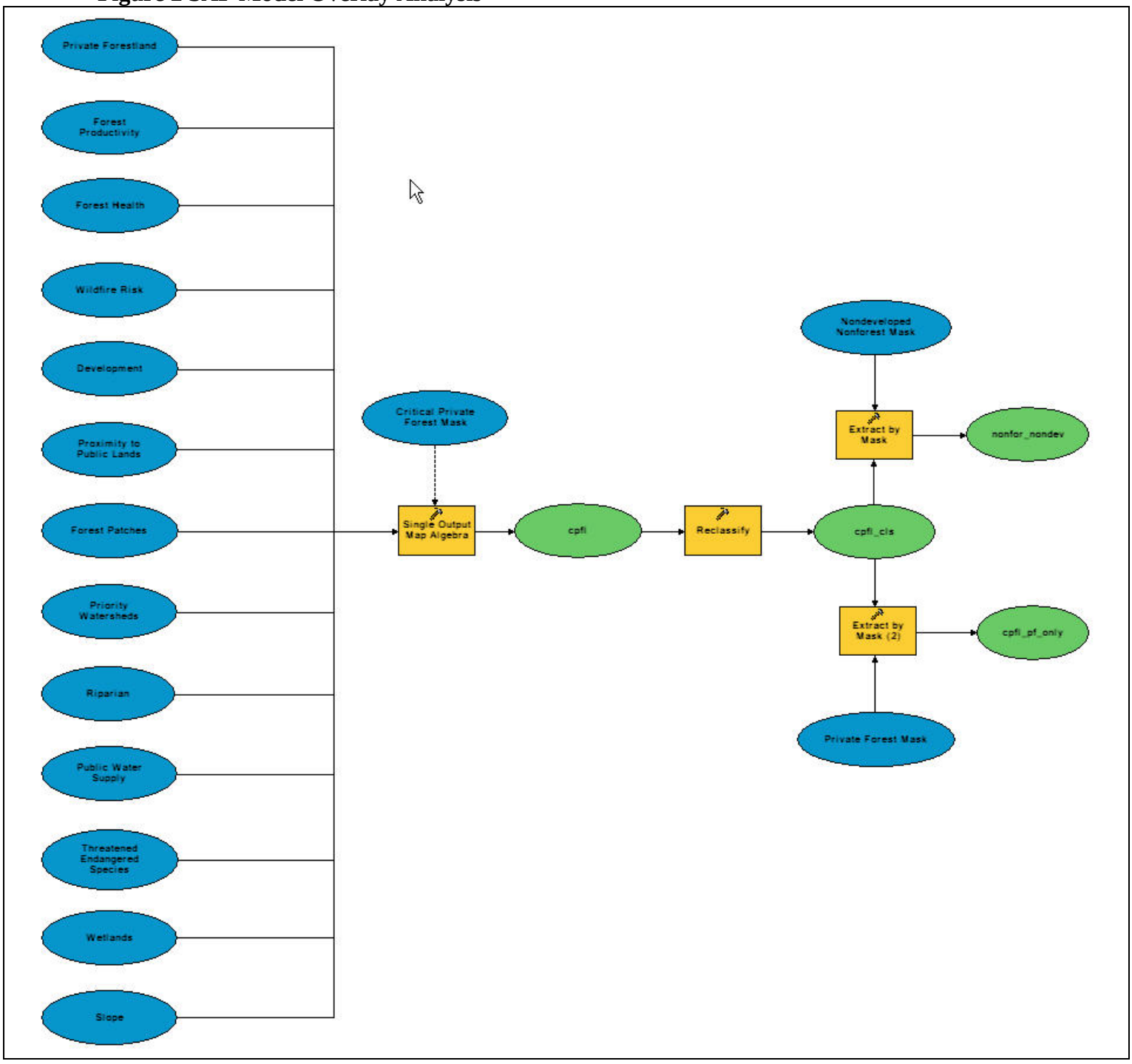


Figure 3 Resource Richness Overlay

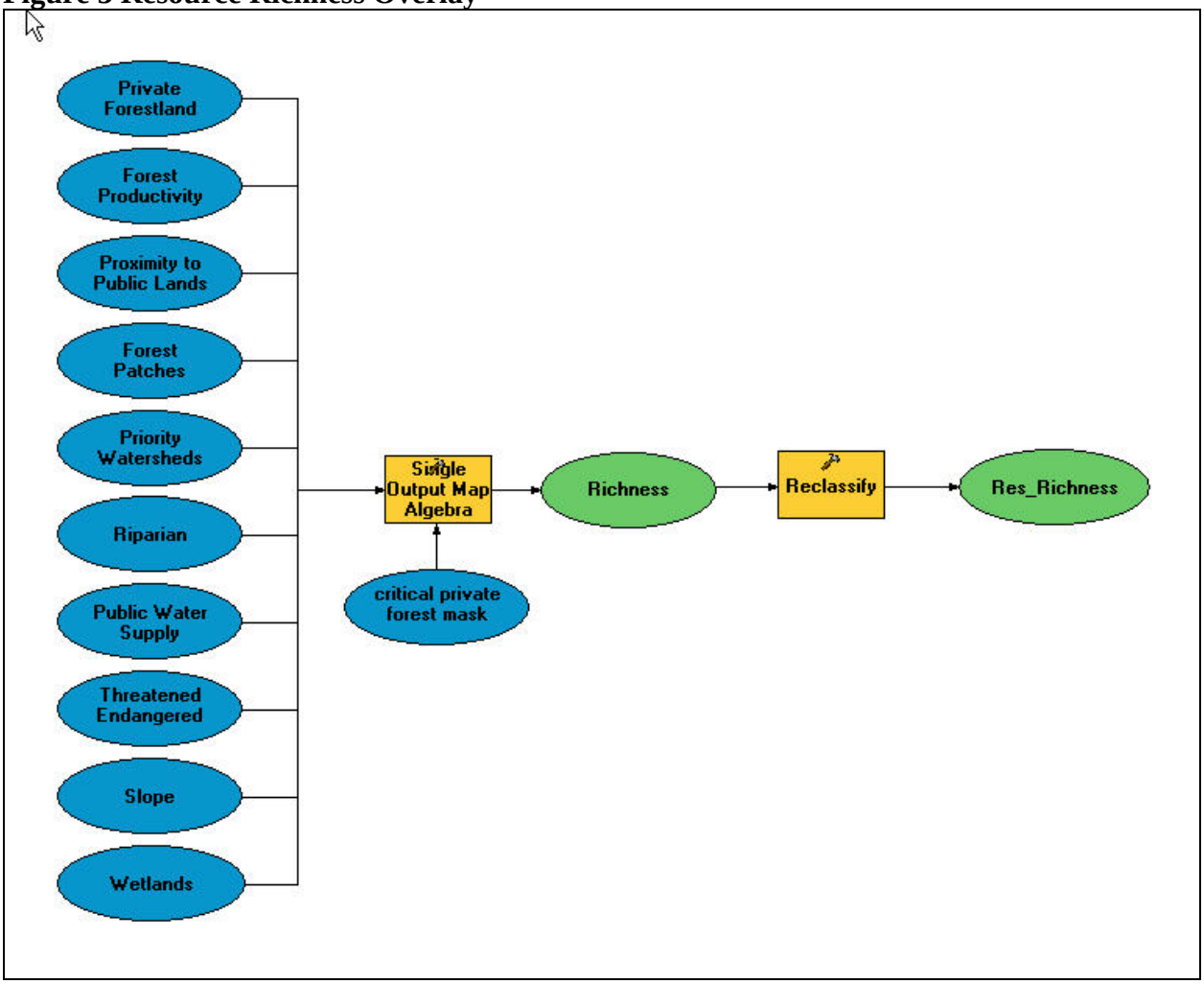
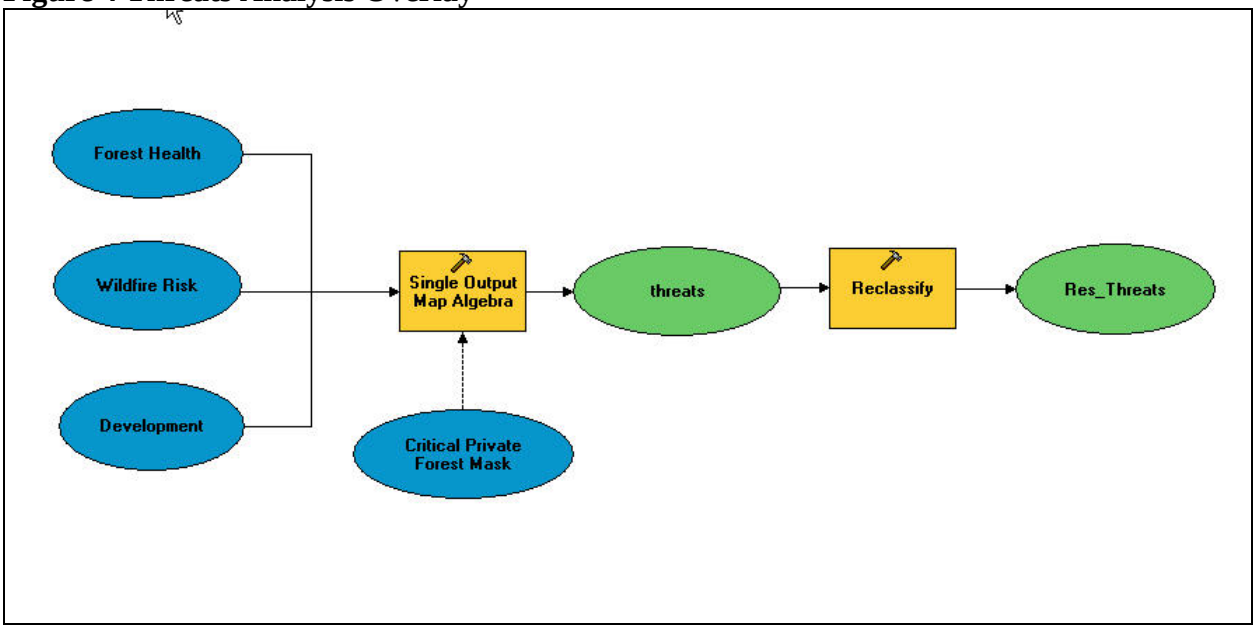


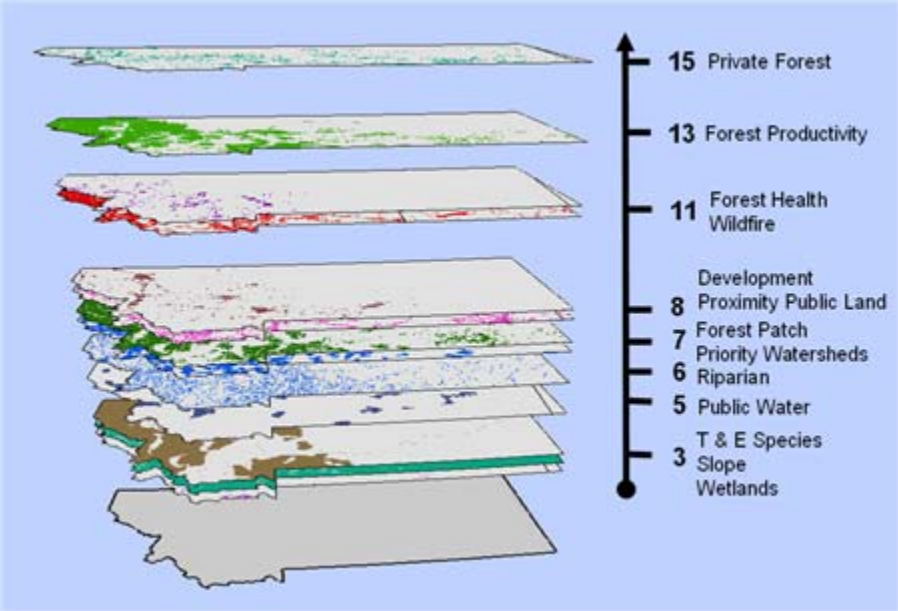
Figure 4 Threats Analysis Overlay

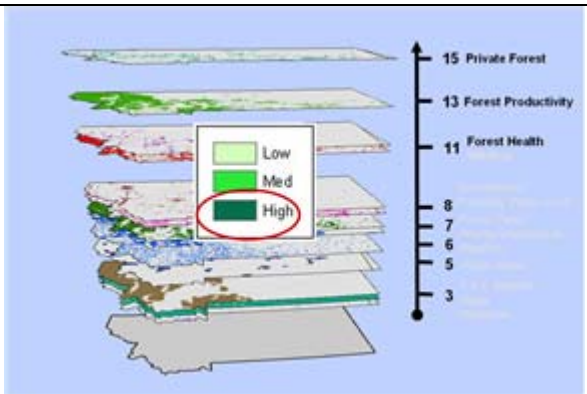


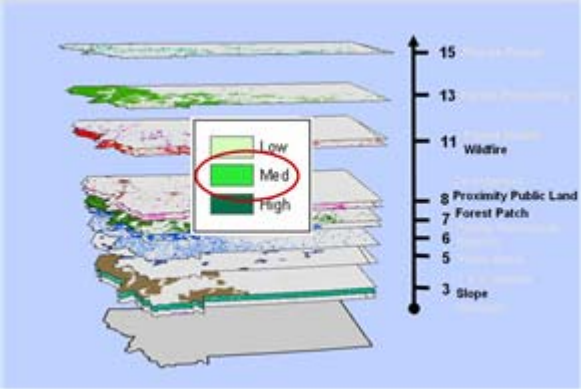
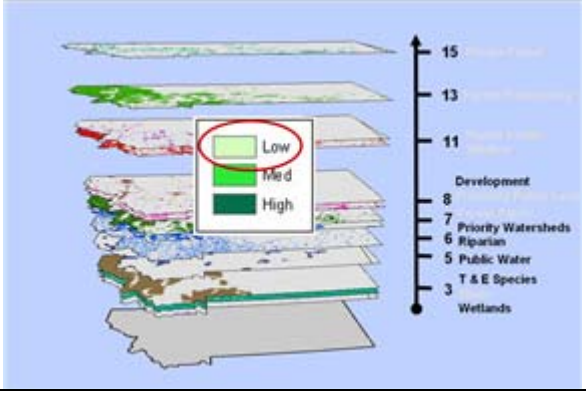
Final Classification

The forest stewardship potential on critical private lands and the two subcategories of private lands, forestlands and non-forestlands & non-developed lands, were subsequently classified into three categories of potential stewardship for each output layer: high, medium and low. The classification breaks were determined by the model input scoring matrix and thresholds set by the MFSSC subcommittee, using the following rules:

The classification was derived from the final rounded integer value for the sum of grid layers used in the "Classified forest stewardship potential on critical private lands" layer (grid cells in a 30 meter x 30 meter unit of analysis).



High - Those that had a value greater than or equal to 39, the sum of the highest three map layers scores.	

Medium – Those that had a value less than 39, the sum of the highest three map layers scores AND had a score greater or equal to 32, the sum of the remaining layers not in the top 3, but with forest related influence in the model.	
Low – Those that had a value less than 32, with no forest related influence in the model	

Analysis Results

Montana forest ownership is shown in Figure 5. The majority of forest land is on US Forest Service land, comprising 59 percent, and corporate forest land accounts for 5 percent of the total. Approximately 19 percent of the forest land is in the non-industrial private forest land category which was the primary focus of this analysis. Parcels in this category range from less than 1 acre to thousands of acres. The Montana Department of Revenue tracks private forest land for forest valuation for acreage of forest land greater than or equal to 15 acres. Stewardship plans, however, can be prepared for forest lands with forest areas of 5 acres or greater. The fine scale of this analysis (30 x 30 meter units of resolution) will allow the DNRC and Forest Extension to evaluate stewardship potential on any size forest acreage in Montana.

Figure 5 Montana Forest Ownership

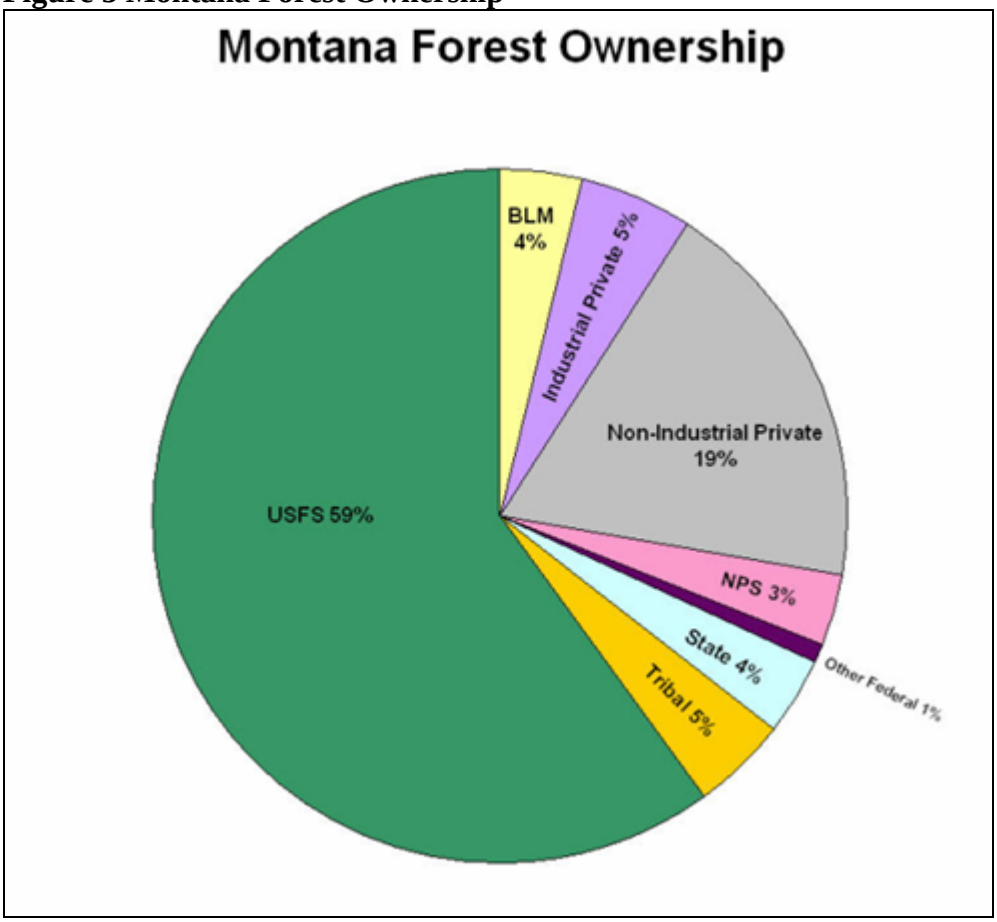


Figure 6 Classified Forest Stewardship Potential on Critical Private Lands

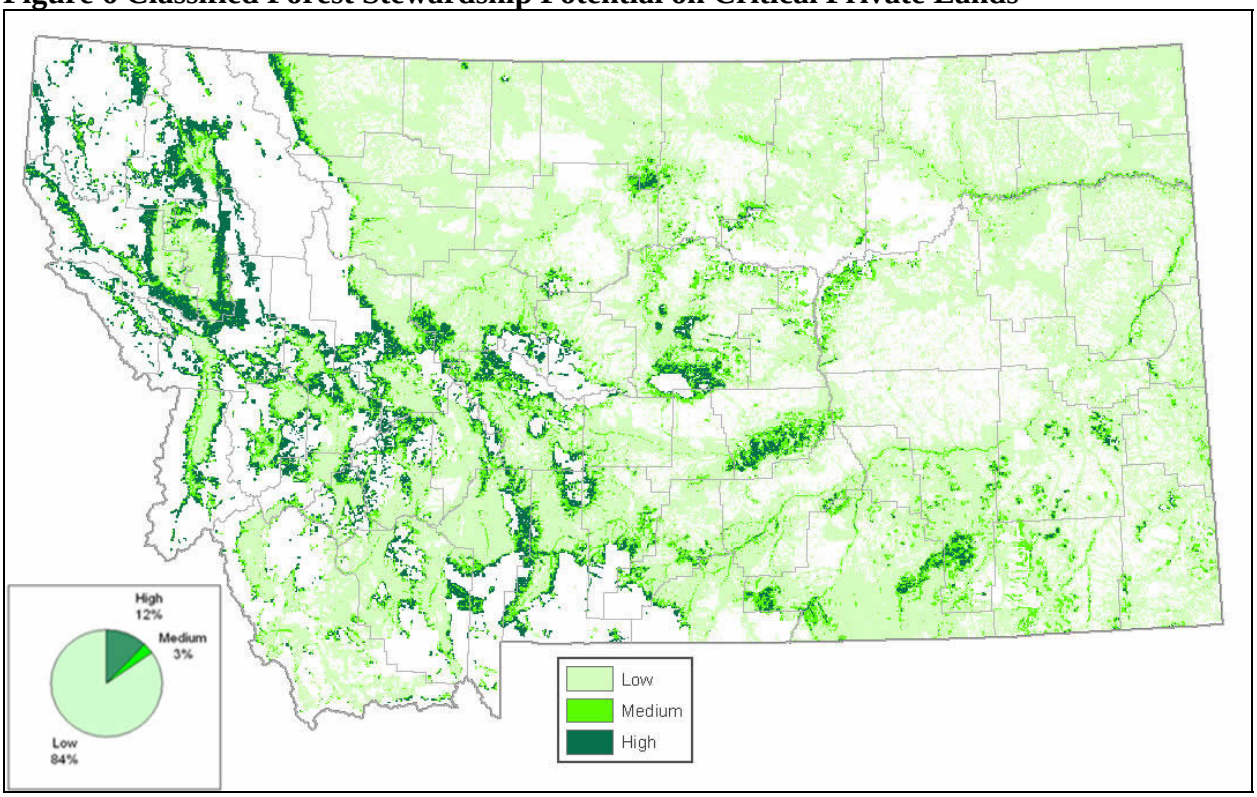


Table 1 Classified Forest Stewardship Potential on Critical Private Lands

Classification	Classified Forest Stewardship Potential					
	Critical Private Forestlands		Critical Private Non-Forestlands & Non-Developed Lands		Critical Private Lands	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
High (3)	3,054,804	61%	906	0%	3,057,359	12%
Medium (2)	839,982	17%	7,096	0%	861,380	3%
Low (1)	1,126,172	22%	19,050,848	100%	21,275,757	84%
Total:	5,020,958		19,058,850		25,194,496	

The classified forest stewardship potential on critical private lands is composed of 12 percent in the high category, 3 percent in the medium category, and 84 percent in the low category, as shown in Figure 6 and Table 1. Of a total of more than 25 million acres, approximately 5 million acres are forestlands and approximately 19 million acres are non-forestlands and non-developed lands. About 3 million acres of forestlands were rated in the high potential category and about 900 acres of non-forestlands and non-developed lands were rated high. Almost all of the non-forestlands and non-developed lands were rated with low potential.

Table 2 Classified Forest Stewardship Potential on Critical Private Forestlands

Classified Forest Stewardship Potential on Critical Private Forestlands				
	High (3)	Medium (2)	Low (1)	Total:
Acres Capable of Stewardship	3,054,804	839,982	1,126,172	5,020,958
Stewardship Plan acres	240,197	36,937	68,851	345,985
Stewardship Plan acres as a percent of Private Forest	7.86%	4.40%	6.11%	6.89%

As reflected in Table 2, of a total of about 5 million acres of currently forested land, about 3 million acres of forestlands were rated in the high potential category, about 800,000 acres were rated in the medium potential category, and about 1 million acres were rated in the low potential category. About 8 percent of high potential forest land, 4 percent of medium and 6 percent of low is currently under stewardship management plans. In general, a larger proportion of the acreage rated high was located in western Montana and a larger proportion of acreage rated low was in eastern Montana.

Figure 7 Classified Forest Stewardship Potential on Critical Private Non-Forestlands & Non-Developed Lands

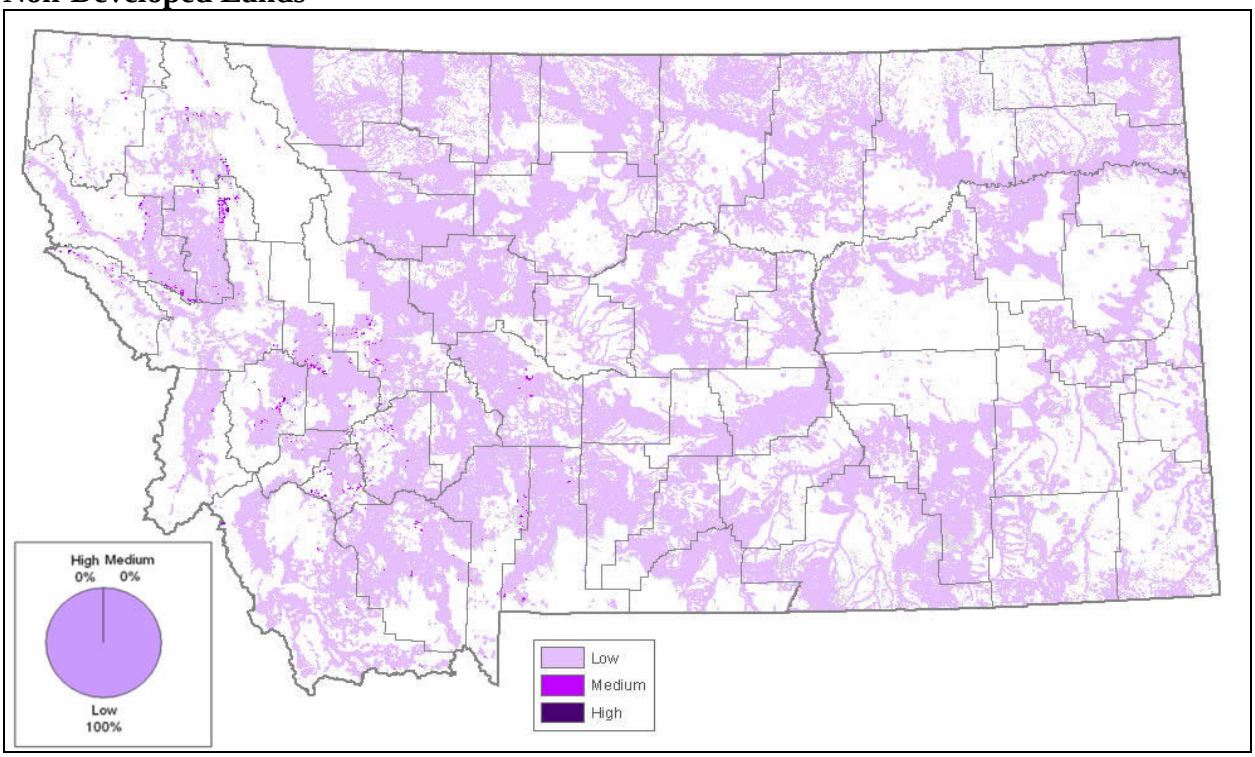
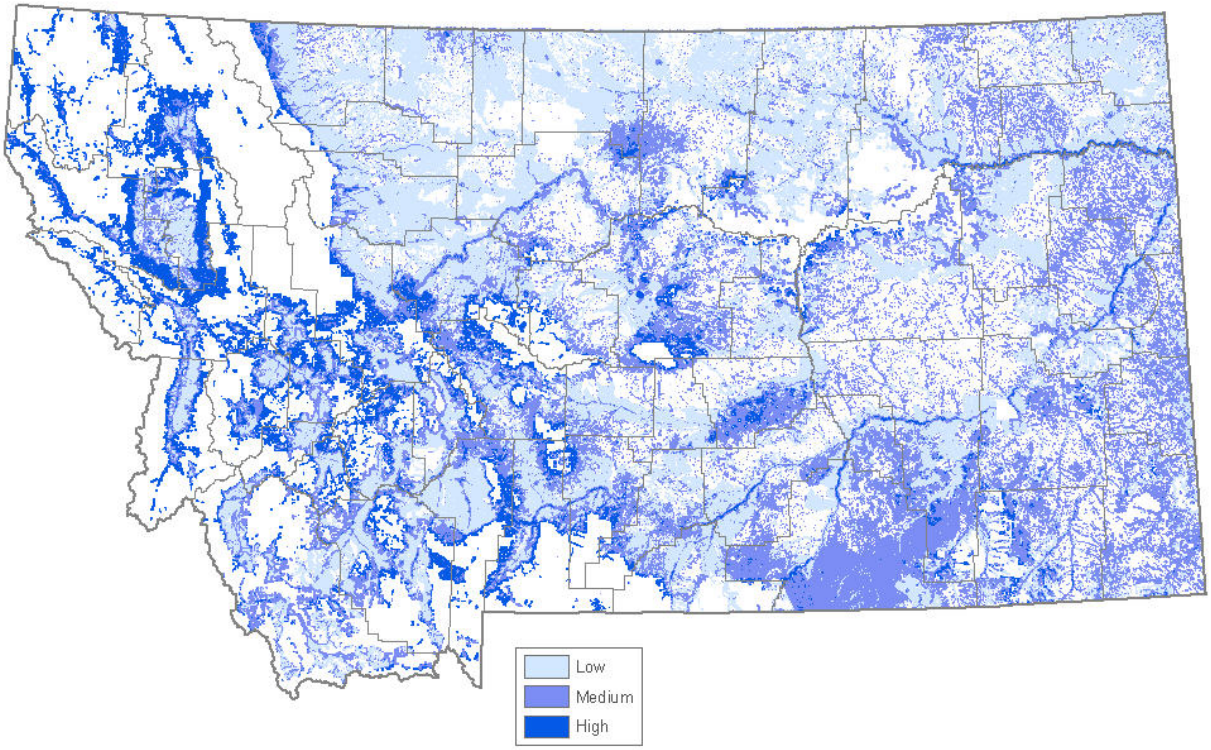


Table 3 Classified Forest Stewardship Potential on Critical Private Non-Forestlands & Non-Developed Lands

Classified Forest Stewardship Potential on Critical Private Non-Forestlands & Non-Developed Lands				
	High (3)	Medium (2)	Low (1)	Total:
Acres Capable of Stewardship	906	7,096	19,050,848	19,058,850
Stewardship Plan acres	2	27	293,363	293,392
Stewardship Plan acres as a percent of Non-forest & Non-dev	0.22%	0.38%	1.54%	1.54%

The classified forest stewardship potential on critical private non-forestlands and non-developed lands is composed almost entirely of the low category of potential, as shown in Figure 7 and Table 3. Of a total of more than 25 million acres, approximately 5 million acres are forestlands and approximately 19 million acres are non-forestlands and non-developed lands. About 3 million acres of forestlands were rated in the high potential category and about 900 acres of non-forestlands and non-developed lands were rated high. Almost all of the non-forestlands and non-developed lands were rated with low potential.

Figure 8 Resource Richness



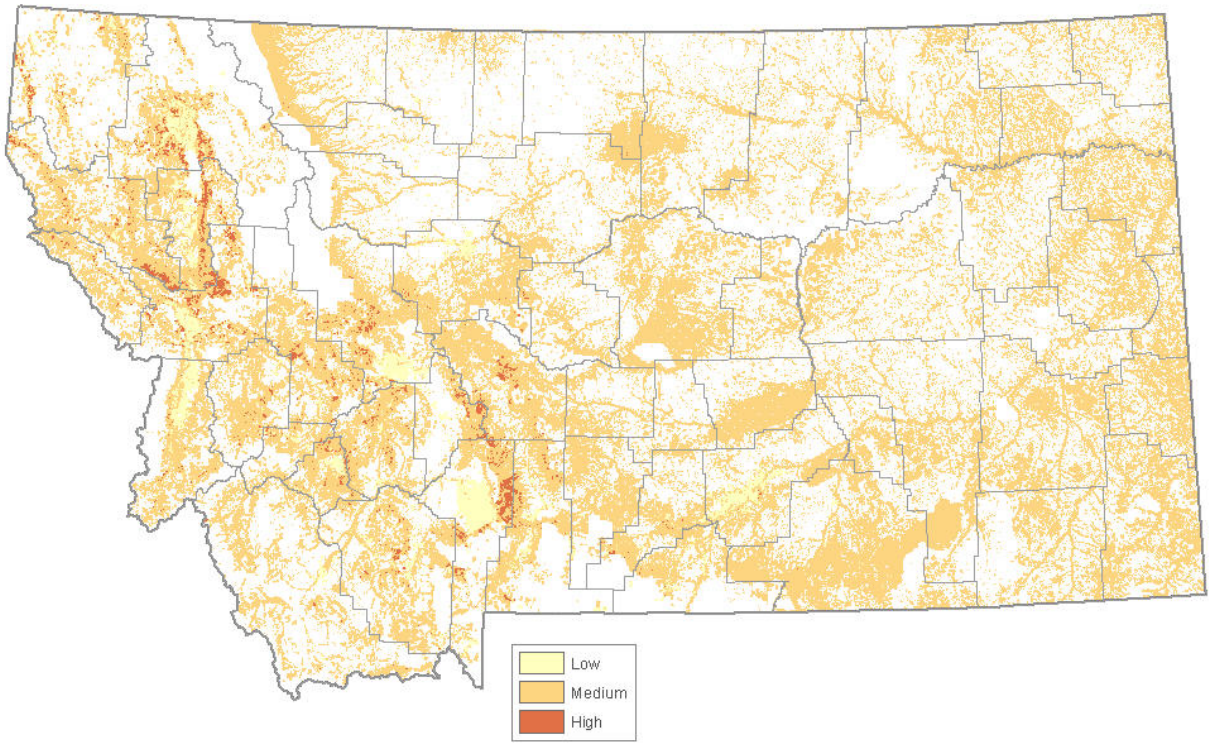
Results of the map layer combinations for resource richness and resource threats were also summarized based on the rating criteria for classified forest stewardship potential on critical private lands, and the results are shown inFigure 8 and Figure 9.

The Resource Richness grid is the final output of the SAP Resource Richness model. A subset of the data themes comprising the Forest Stewardship Potential Analysis model (SAP_model) were added together on a cell-by-cell basis to derive a richness score. The logic for weighting factors used in the SAP_model could not be used for the resource richness, since the total list of layers was separated into two categories. Therefore the Jenks method or "Natural Breaks" classification method in the ESRI ArcView software was used to derive the resource richness categories of High, Med, or Low. The natural breaks thresholds divide the classification into High (30-66), Medium (14-29), or Low (3-13).

The same data layers were used as for the Forest Stewardship Potential model with the exception of Forest Health, Wildfire Risk, and Development.

The resource threat layers are Forest Health, Wildfire Risk, and Development.

Figure 9 Resource Threats



The Resource Threats grid is the final output of the SAP Resource Threats model. A subset of the data themes comprising the Forest Stewardship Potential Analysis model (SAP_model) were added together on a cell-by-cell basis to derive a richness score. The logic for weighting factors used in the SAP_model could not be used for the resource threats, since the total list of layers was separated into two categories. Therefore the Jenks method or "Natural Breaks" classification method in the ESRI ArcView software was used to derive the resource threats categories of High, Med, or Low. The natural breaks thresholds divide the classification into High (12-30), Medium (9-11), or Low (8)

Existing and historic forest stewardship plans

Several of the objectives of the SAP project involved assessment of the stewardship values in relation to the non-industrial private forest (NIPF) plans that have been developed since 1991. The assessment involved identifying where the management plans were located, and determining what percentage of existing NIPF management plans were on the state's priority stewardship lands. This also provided a basis for establishing future practices that can improve effectiveness in addressing priority needs based on landscape scale resource issues.

Although Montana has over 1500 completed plans developed under the FSP, there were approximately 1,200 non-industrial private forest ownership properties, representing approximately 650,000 total acres that were intact with accurate ownership information.

Figure 10 shows the PLSS sections (1x1 square mile) with completed stewardship plans, overlaid on a map of all potential forest stewardship values (high, medium, low). A total of 220,424 acres were estimated to be on lands rated high for forest stewardship potential, a total of 12,185 acres were rated medium, and a total of 406,866 were rated low. Approximately 290,000 of the lands rated in the low category, or 72 percent, were estimated to be on non-forestlands and non-developed lands. Looking only at the stewardship plans on private forestlands, 69 percent (240,197 acres) were on lands rated high for forest stewardship potential, 11 percent were on lands rated medium, and 20 percent on lands rated low. Caution is advised in reviewing these results, due to the lack of precise location of stewardship plan mapping and differences in acreage reporting over time. Further details are provided later in this section.

Figure 10 Existing Stewardship Plans for Montana

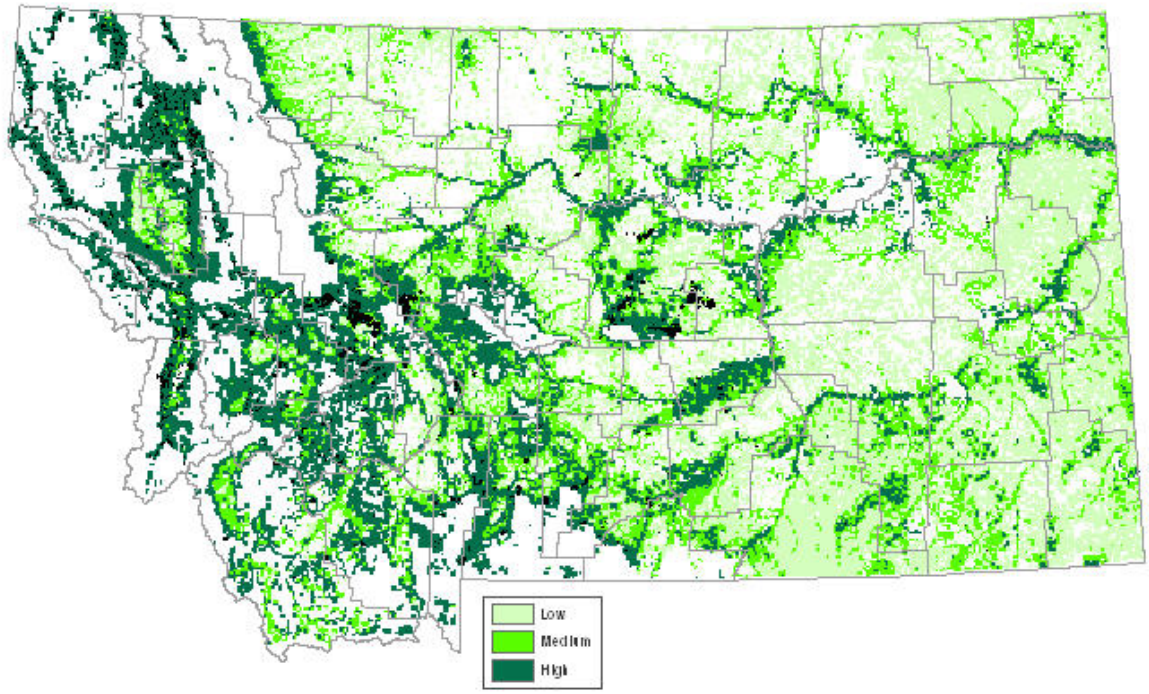


Table 4 Existing Stewardship Plans for Montana

Classified Forest Stewardship Potential on Critical Private Forestlands				
	High (3)	Medium (2)	Low (1)	Total:
Acres Capable of Stewardship	3,054,804	839,982	1,126,172	5,020,958
Stewardship Plan acres	240,197	36,937	68,851	345,985
Stewardship Plan acres as a percent of Private Forest	7.86%	4.40%	6.11%	6.89%

There were several challenges in accomplishing this analysis in Montana. Early planning efforts did not require detailed map locations of the forest plan on the property, and thus, no map records exist for the majority of properties. Incomplete legal descriptions exist for most plans, and changes in ownership since the plan were developed also contributed to the challenge. Fortunately, Montana has developed a comprehensive cadastral mapping effort involving all parts of the state in one consistent geodatabase. This provides the ability to accurately map future stewardship plans in conjunction with landowners in planning workshops. It also provides some ability to map historic plans based on the owner name in property tax record databases. The contracted portion of this project did not include funding for the labor intensive mapping required to map every historic plan. DNRC staff plan to continue to develop these individual plan locations over the next few years.

In lieu of the ability to overlay the critical stewardship lands on NIPF plans and develop reports on acreage totals, a method was developed to assign stewardship potential to each section of land and associate those values with the portion of plans in each section of land. DNRC provided township, range and section descriptions for private properties with forest stewardship plans in two databases and two ArcView shapefiles, containing a total of 1228 owner records. There were 33 records with no township, range and section and one record with an incorrect township, range and section that could not be used. The remaining township, range and section descriptions were used as provided by DNRC.

The databases were combined and a unique identification number was added for each owner. The township, range, and section for each record were standardized. A record was created for each unique township, range, and section combination. The total acreage for each owner was divided by the total number of sections for each owner to determine the average acres per section. About 200 records contain a total average acre per section that is larger than 640 acres (the standard size for one section). That was most likely a result of incomplete township, range and section descriptions for the property. The resulting database was joined to the public land survey shape file and the sections selected were extracted to create a PLSS section map with apportioned stewardship planning acres based on the reported values in the database tables maintained by DNRC. The GIS section layer included a unique identification number for each owner in that section (with up to five owners in some sections), the average acres per owner, and the total average acres of all owners in each section.

The final step in summarizing the stewardship priority for each plan was to overlay the apportioned section map on each of the final stewardship analysis layers and report the acres of each plan in high, medium and low categories. Some sections included a mix of the three categories, others included a predominance of one category. Without knowing where in the section the precise forest plan location was, some level of abstraction was required in assigning the values.

For the plans on critical private lands, the majority value was assigned to all plan acres in the section, regardless of the number of acres of critical private lands in the section. For instance, if 40 percent of a section included critical private lands and 60 percent did not, the section was still given a value. If 51 percent of the critical private forest lands were medium potential and 49 percent were low potential, all acres in the section were assigned to the medium potential category.

Although the same logic of not knowing which part of a section included acres in a stewardship plan applied to forest and non-forest portions of all critical private lands, the spatial location and proportion of existing forestland was known. As a result, the process was modified slightly in reporting acreage by stewardship potential categories for forest and non-forest. An additional level of proportion was assigned based on the proportion of forest and non-forestlands for the acreage summaries of categories of stewardship potential, and these proportions were passed through to the stewardship plan acres. A detailed description of the exact GIS procedures used for this analysis is included in Appendix B.

Appendices

Appendix A: Final Maps

Map 1 – Classified Forest Stewardship Potential on Critical Private Lands for Montana

Map 2 - Classified Forest Stewardship Potential on Critical Private Lands and Existing Stewardship Plans for Montana

Map 3 - Classified Forest Stewardship Potential on Critical Private Forestlands and Existing Stewardship Plans for Montana

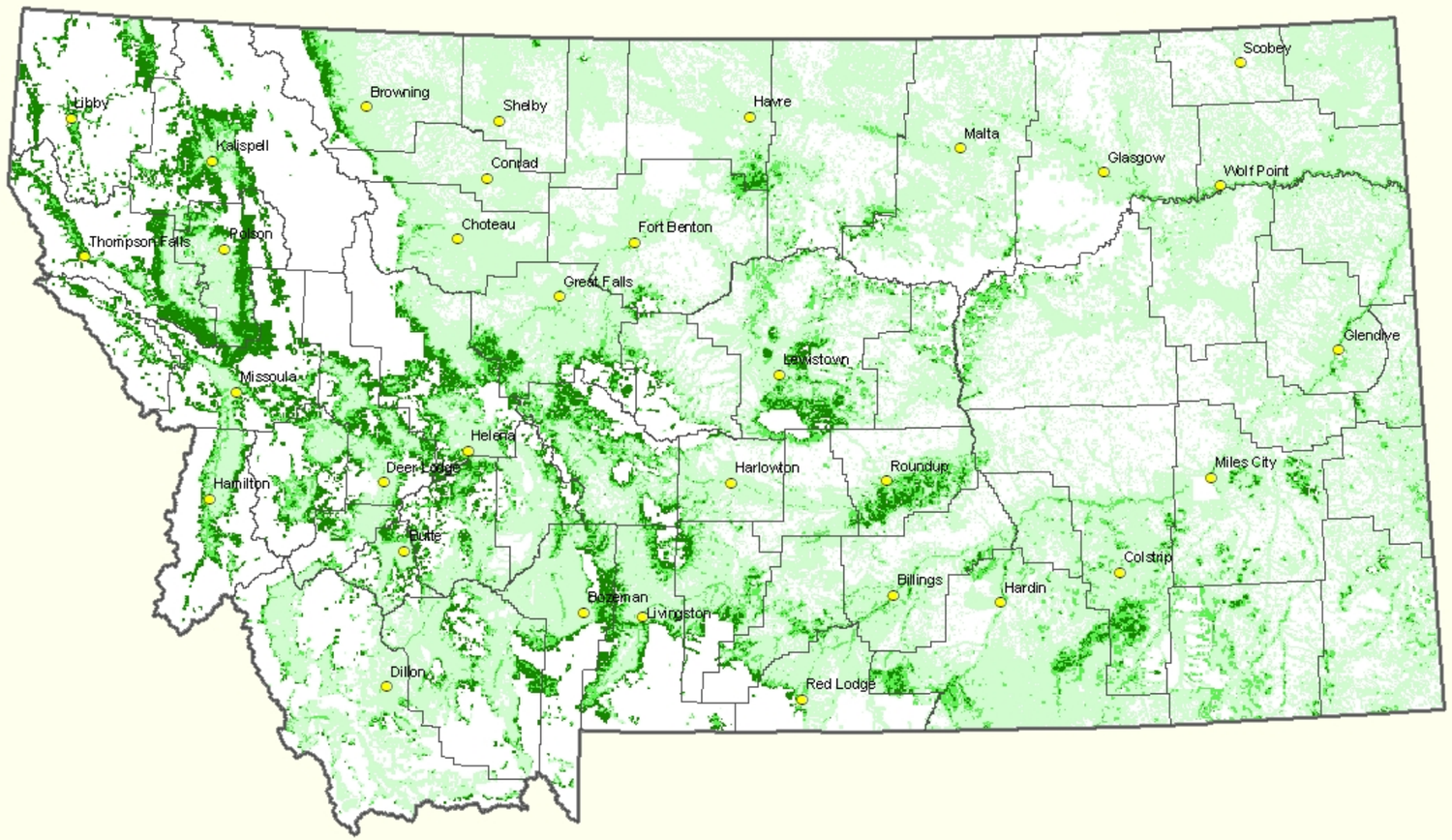
Map 4 - Resource Richness in Montana

Map 5 - Resource Threats in Montana

Map 6 - Classified Forest Stewardship Potential on Critical Non-Forestlands & Non-Developed Lands and Existing Stewardship Plans for Montana

Map 7 - Forestland Ownership

1 Classified Forest Stewardship Potential on Critical Private Lands for Montana



Stewardship Potential

- Low
- Medium
- High
- Areas Without Stewardship Potential

N

25 0 25 50 75 100 Miles

Montana Department of Natural Resources

Robert Harrington, State Forester
Dan Rogers, Stewardship Coordinator

Weighting Scheme by Layer:

15% Private Forestland
13% Forest Productivity
11% Forest Health
11% Wildfire Risk
8% Development Level
8% Proximity to Public Lands
7% Forest Patches
7% Priority Watersheds
6% Riparian River Areas
5% Public Water Supply
3% Threatened & Endangered Species
3% Slope
3% Wetlands

MAP NOTES:

Date: 12/20/2006
Datalayer: cfsp_cpl
File name: Map1 - Stewardship Potential.mxd
Map by: Geodata Services, Inc.

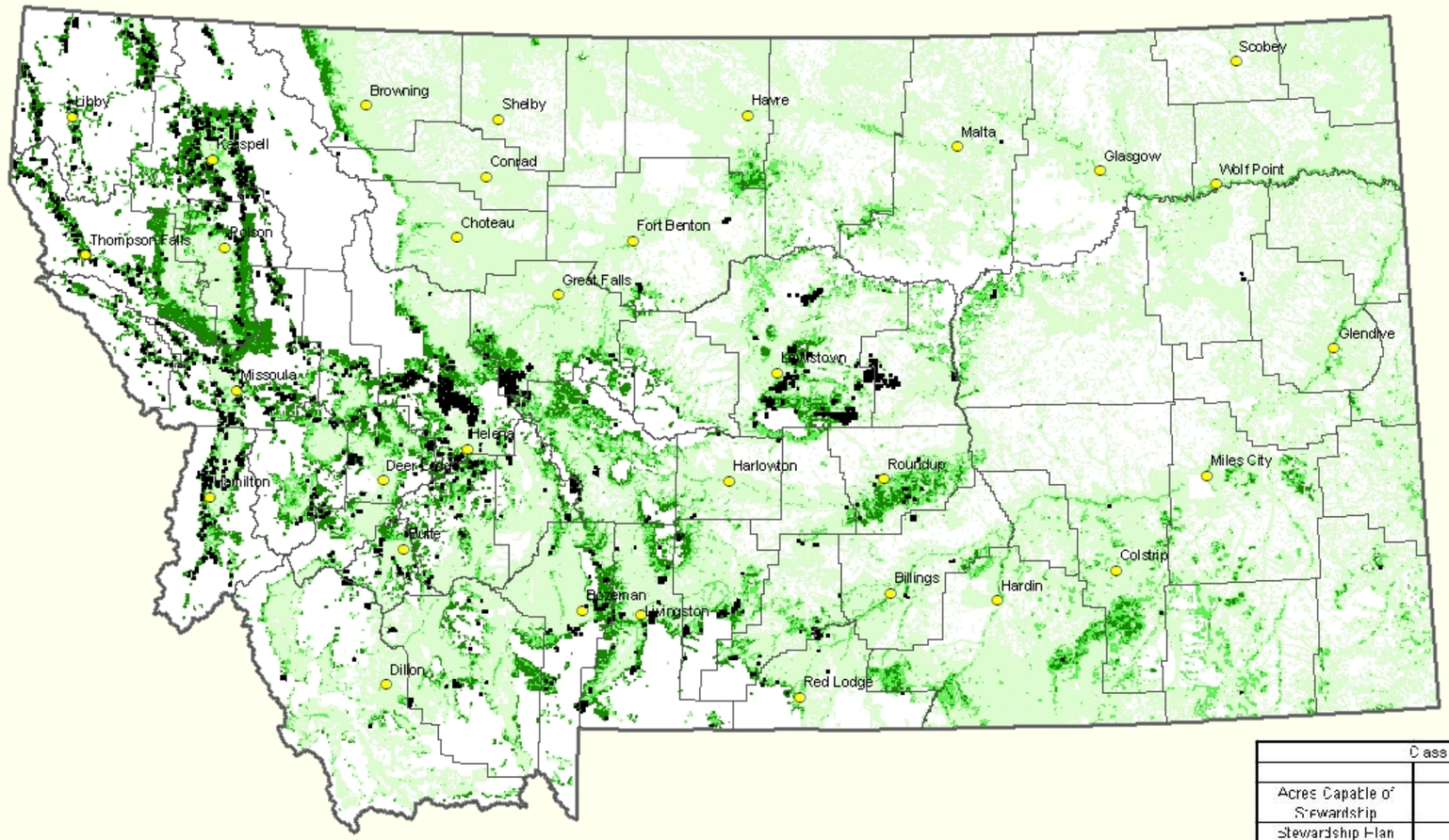
CONTACT INFORMATION:

Dan Rogers
Montana Dept. of Natural Resources
2705 Spurgin Road
Missoula, MT 59804
danrogers@mt.gov

Classification	Classified Forest Stewardship Potential					
	Critical Private Forestlands		Critical Private Non-Forestlands & Non-Developed Lands		Critical Private Lands	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
High (3)	3,054,804	61%	906	0%	3,057,359	12%
Medium (2)	739,902	17%	7,096	0%	961,000	0%
Low (1)	1,126,172	22%	19,050,848	100%	21,275,757	84%
Total:	5,020,988		19,058,850		25,194,496	

2

Classified Forest Stewardship Potential on Critical Private Lands for Montana
and Existing Stewardship Plans for Montana



Stewardship Potential

- Low
- Medium
- High
- Stewardship Plans
- Areas without Stewardship Potential

N

25 0 25 50 75 100 Miles

Montana Department of Natural Resources

Robert Harrington, State Forester
Dan Rogers, Stewardship Coordinator

Classified Forest Stewardship Potential on Critical Private Lands				
	High (3)	Medium (2)	Low (1)	Total
Acres Capable of Stewardship	3,057,359	861,380	21,275,757	25,194,496
Stewardship Plan acres	220,424	12,185	406,865	639,475
Stewardship Plan acres as a percent of Acres Capable of Stewardship	7.21%	1.41%	1.91%	2.54%

MAP NOTES:

Date: 12/20/2006
Datalayer: cfsp_cpl
& sap_sections2.shp
File name: Map2 - Existing Plans.mxd
Map by: Geodata Services, Inc.

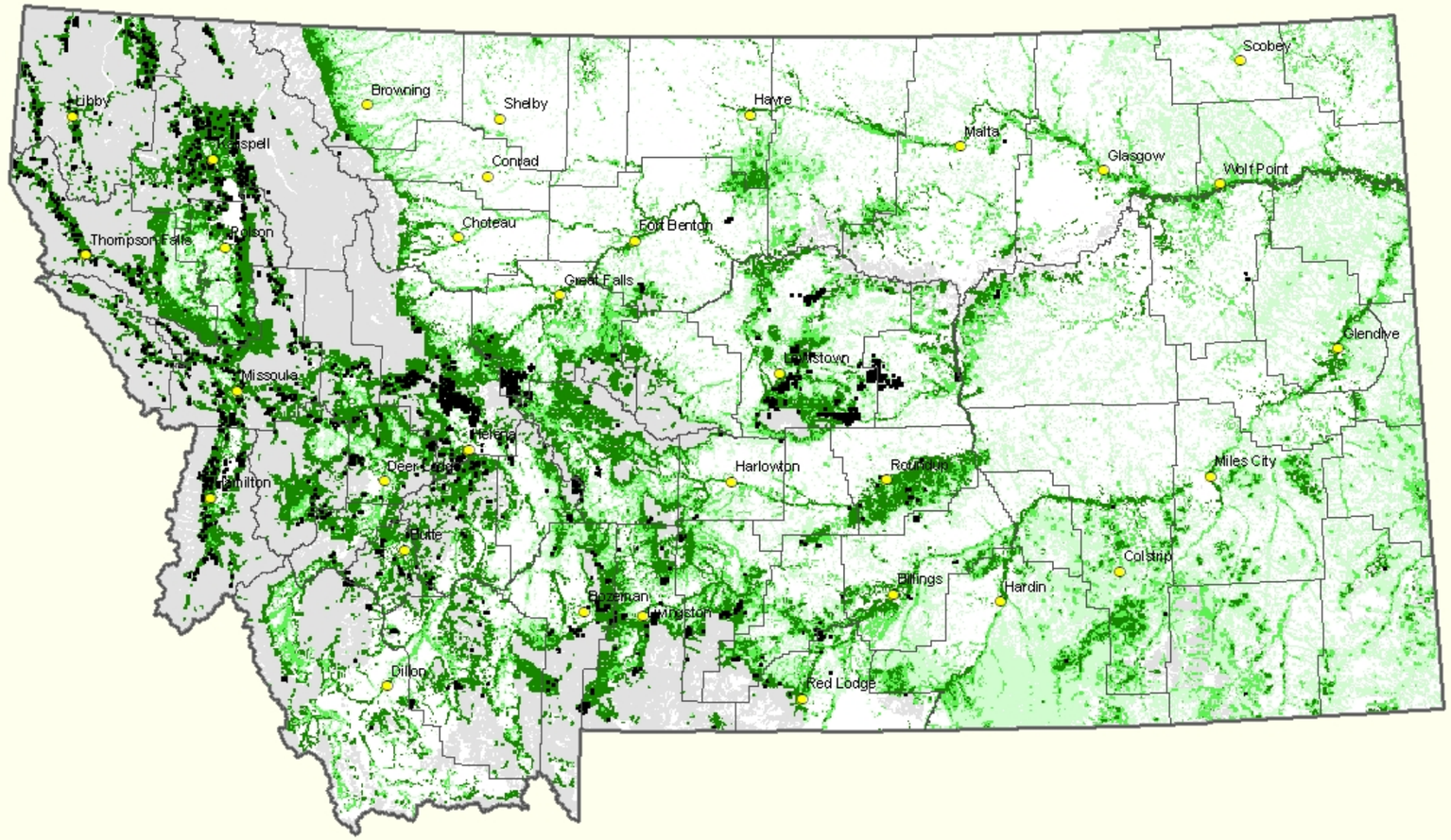
CONTACT INFORMATION:

Dan Rogers
Montana Dept. of Natural Resources
2705 Spurgin Road
Missoula, MT 59804
danrogers@mt.gov

Classification	Classified Forest Stewardship Potential					
	Critical Private Forestlands		Critical Private Non-Forestlands & Non-Developed Lands		Critical Private Lands	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
High (3)	3,054,804	61%	906	0%	3,057,359	12%
Medium (2)	839,982	17%	7,096	0%	861,380	3%
Low (1)	1,126,172	22%	19,060,848	100%	21,275,757	84%
Total:	5,020,953		19,068,850		25,194,496	

3

Classified Forest Stewardship Potential on Critical Private Forestlands*
and Existing Stewardship Plans for Montana



Stewardship Potential

Low	Stewardship Plans
Medium	Non-Forest
High	All Forest*

N

25 0 25 50 75 100 Miles

Montana Department of Natural Resources

Robert Harrington, State Forester
Dan Rogers, Stewardship Coordinator

* **Includes Classes of Land Cover (NLCD):**
- **41 (Deciduous Forest)**
- **42 (Evergreen Forest)**
- **43 (Mixed Forest)**
- **91 (Woody Wetlands)**

MAP NOTES:

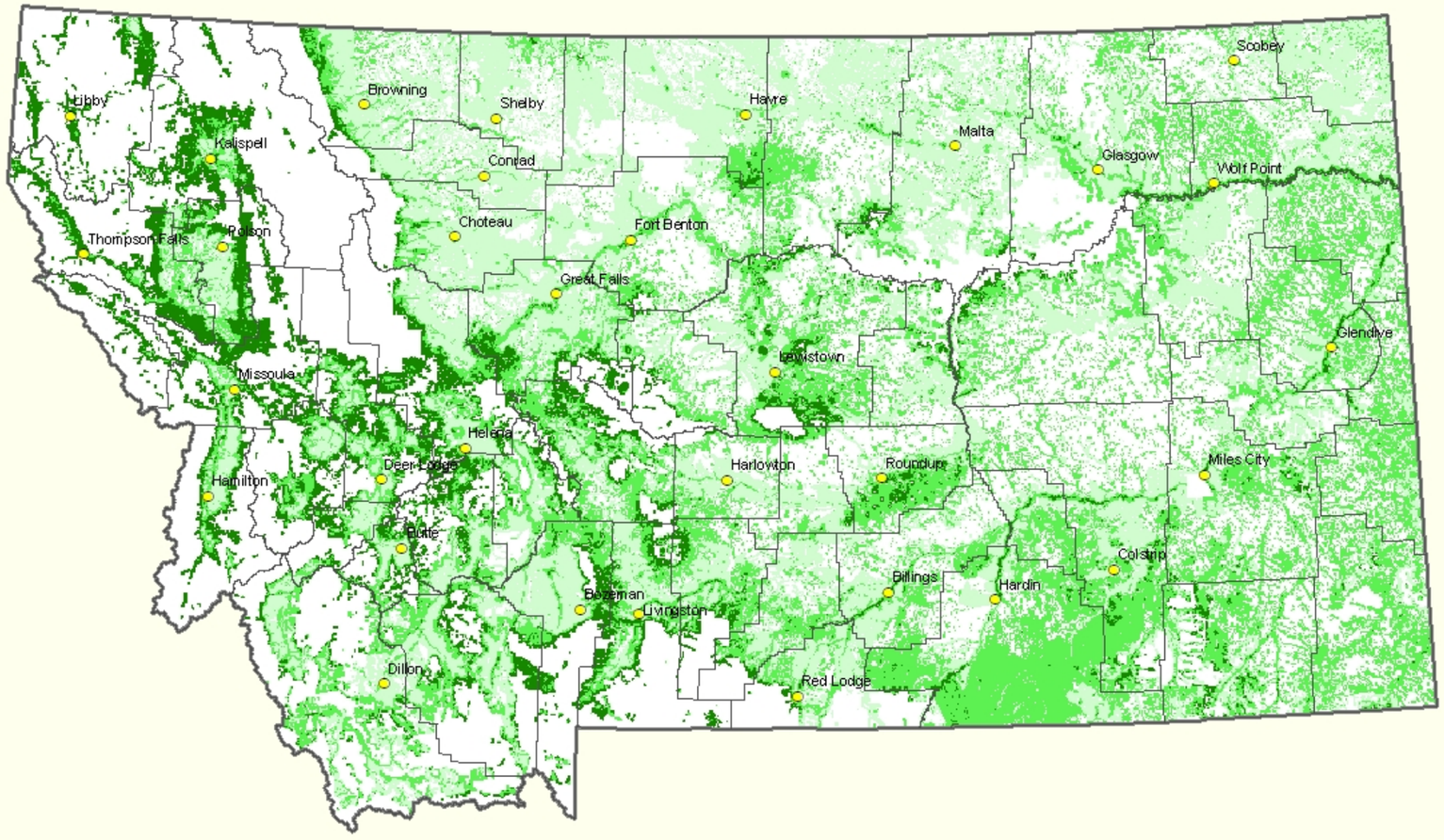
Date: 12/20/2006
Datalayer: cfsp_pf
& sap_sections2.shp
File name: Map3 - Private Forestlands.mxd
Map by: Geodata Services, Inc.

CONTACT INFORMATION:

Dan Rogers
Montana Dept. of Natural Resources
2705 Spurgin Road
Missoula, MT 59804
danrogers@mt.gov

Classified Forest Stewardship Potential on Critical Private Forestlands				
	High (3)	Medium (2)	Low (1)	Total:
Acres Capable of Stewardship	3,054,804	839,982	1,126,172	5,020,9
Stewardship Plan acres	240,197	36,937	68,851	345,9
Stewardship Plan acres as a percent of Private Forest	7.86%	4.40%	6.11%	6.8

4



Resource Richness*

Montana

Resource Richness

- Low
- Medium
- High
- Areas without Stewardship Potential

N

25 0 25 50 75 100 Miles

Montana Department of Natural Resources

Robert Harrington, State Forester
Dan Rogers, Stewardship Coordinator

* **Includes Data Themes:**

- Private Forestland
- Forest Productivity
- Proximity to Public Lands
- Forest Patches
- Priority Watersheds
- Riparian River Areas
- Public Water Supply
- Threatened & Endangered Species
- Slope
- Wetlands

MAP NOTES:

Date: 12/20/2006
Datalayer: res_richness
File name: Map4 - Resource Richness.mxd
Map by: Geodata Services, Inc.

CONTACT INFORMATION:

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Montana Dept. of Natural Resources
2705 Spurgin Road
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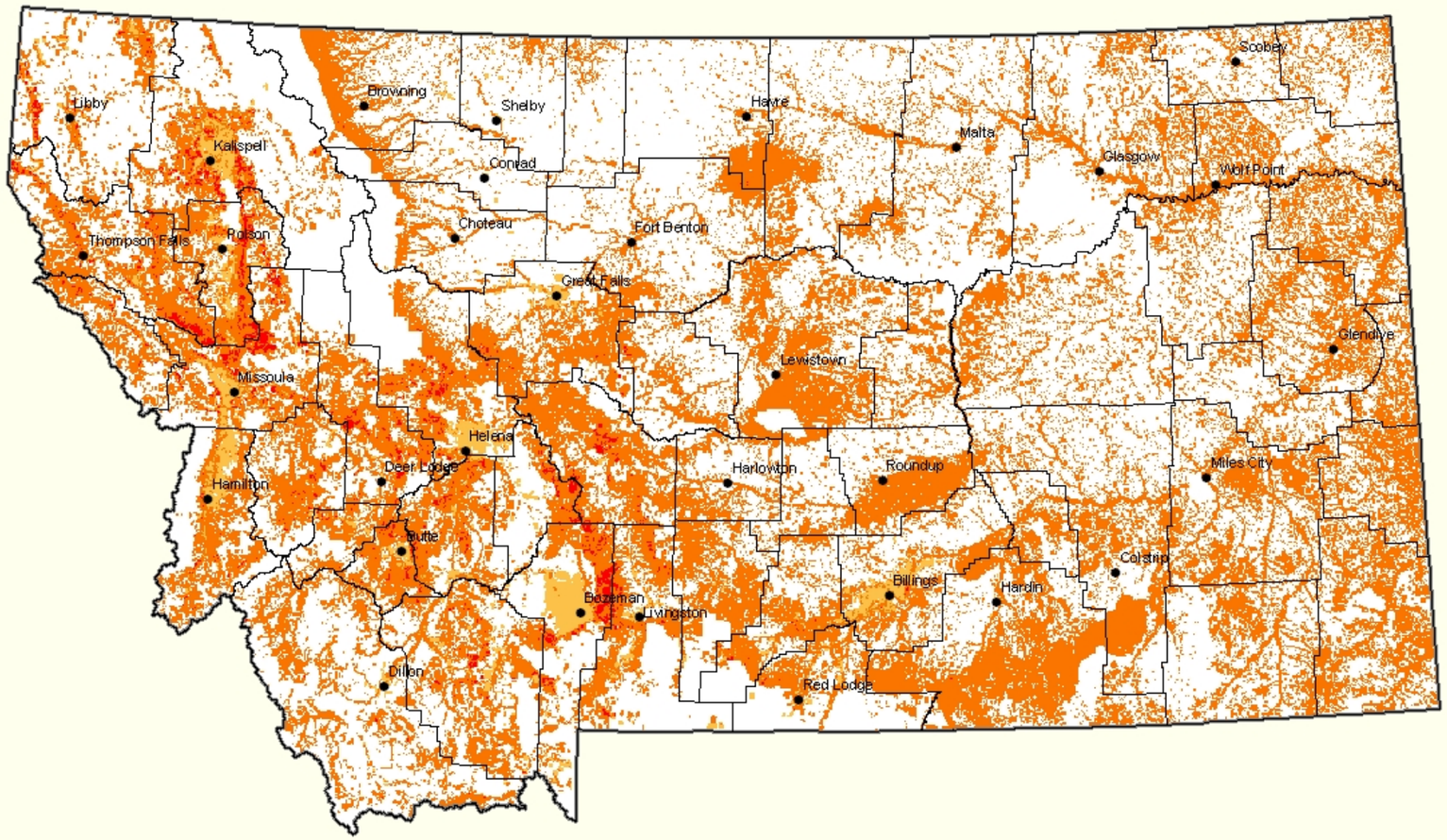
5



Resource Threats*

Montana

Resource Threats

- Low
- Medium
- High
- Areas without Stewardship Potential

N

25 0 25 50 75 100 Miles

Montana Department of Natural Resources

Robert Harrington, State Forester
Dan Rogers, Stewardship Coordinator

* **Includes Data Themes:**
Forest Health
Wildfire Risk
Development

MAP NOTES:

Date: 12/20/2006
Datalayer: res_threats
File name: Map5 - Resource Threats.mxd
Map by: Geodata Services, Inc.

CONTACT INFORMATION:

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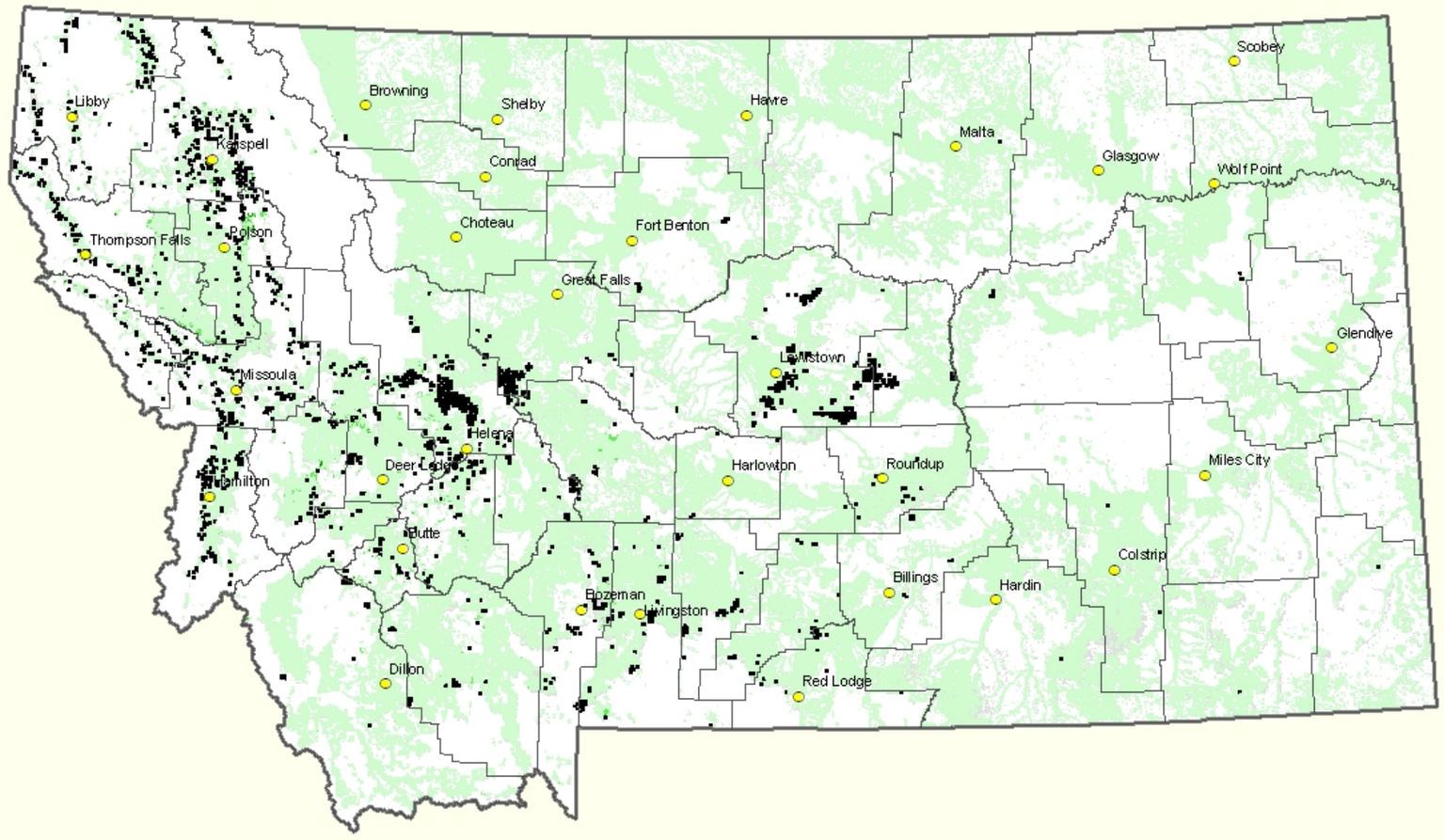
2705 Spurgin Road
Missoula, MT 59804
danrogers@mt.gov

6 Classified Forest Stewardship Potential on Critical Non-Forestlands & Non-Developed Lands*
and Existing Stewardship Plans for Montana



Stewardship Potential

- Low
- Medium
- High
- Stewardship Plans
- Areas without Stewardship Potential
- Private Forest

N

25 0 25 50 75 100 Miles

Montana Department of Natural Resources

Robert Harrington, State Forester
Dan Rogers, Stewardship Coordinator

* Includes Classes of Land Cover (NLCD):
- 31 (Bare Rock/Sand/Clay)
- 33 (Transitional)
- 51 (Shrubland)
- 71 (Grasslands/Herbaceous)
- 81 (Pasture/Hay)
- 82 (Row Crops)
- 83 (Small Grains)
- 84 (Fallow)
- 85 (Urban/Recreational Grasses)
- 92 (Emergent Herbaceous Wetlands)

MAP NOTES:

Date: 12/20/2006
Datalayer: cfsp_cpnf
& sap_sections2.shp
File name: Map6 - NonForest & NonDeveloped.mxd
Map by: Geodata Services, Inc.

CONTACT INFORMATION:

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2705 Spurgin Road
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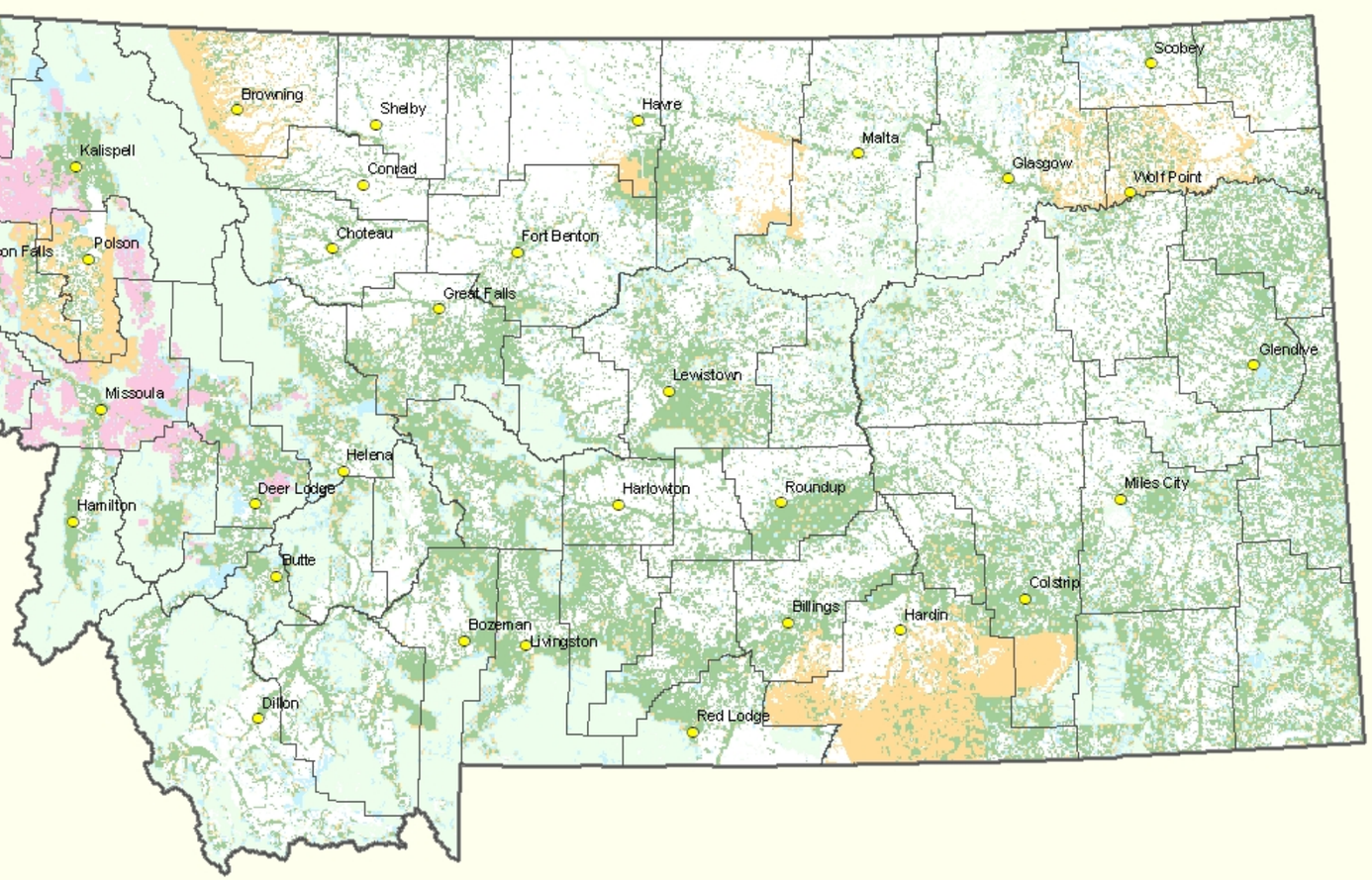
danrogers@mt.gov

Classified Forest Stewardship Potential on Critical Private Non-Forestlands & Non-Developed Lands				
	High (3)	Medium (2)	Low (1)	Total:
Acres Capable of Stewardship	906	7,096	19,050,848	19,058,850
Stewardship Plan acres	2	27	293,363	293,392
Stewardship Plan acres as a percent of Non-forest & Non-dev	0.22%	0.38%	1.54%	1.54%

7

Forestland Ownership



Forestland Ownership

- Federal
- State
- Tribal
- NIPF
- Industry

N

25 0 25 50 75 100 Miles

Montana Department of Natural Resources

Robert Harrington, State Forester
Dan Rogers, Stewardship Coordinator

MAP NOTES:

Date: 12/20/2006
Datalayer: forestlandown
File name: Map7 - Forestland Ownership.mxd
Map by: Geodata Services, Inc.

CONTACT INFORMATION:

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Appendix B: Documentation and Metadata

Metadata in FGDC compatible form was developed for the final analysis steps and included process steps for each component of the analysis as shown below. Metadata on the source layers was acquired for all layers possible, and came in a variety of formats. Some were in FGCD format, others were not. These are provided as is in the data archive available from DNRC.

```
Identification_Information:
  Citation:
    Citation_Information:
      Originator: Montana Department of Natural Resources and Conservation
      Publication_Date: 12/14/06
      Title: Stewardship Potential
      Geospatial_Data_Presentation_Form: raster digital data
      Online_Linkage: \\MARIAS\C_Data on Marias\DNRC_SAP\ModelOutput\fsp_cpl
  Description:
    Abstract: State-wide assessment of critical private forestland in Montana
in 2006
    Purpose: This state-wide assessment was accomplished using geographic
information system (GIS) analytic techniques and involved developing three
spatial layers-Forest Resource Richness, Forest Resource Threat, and Critical
Private Forestland. Results of the analysis were used to demonstrate the
value of forests and forestry on the regional economy, environmental health,
and quality of life.
  Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 12/14/06
    Currentness_Reference: publication date
  Status:
    Progress: Complete
    Maintenance_and_Update_Frequency: Unknown
  Spatial_Domain:
    Bounding_Coordinates:
      West_Bounding_Coordinate: -116.184204
      East_Bounding_Coordinate: -103.605598
      North_Bounding_Coordinate: 49.182457
      South_Bounding_Coordinate: 44.233717
  Keywords:
    Theme:
      Theme_Keyword_Thesaurus: None
      Theme_Keyword: None
  Access_Constraints: None
  Use_Constraints:
    Please refer interested parties to Montana Department of Natural
Resources (MTDNRC) for the most recent version of the data.

    This data set is provided "as-is" without warranty of any kind.  MTDNRC
makes no representations or warranties whatsoever with respect to the
accuracy or completeness of this data set and assumes no responsibility for
the suitability of this data set for a particular purpose; and MTDNRC will
not be liable for any damages incurred as a result of errors in this data
set.
  Point_of_Contact:
    Contact_Information:
      Contact_Organization_Primary:
```

Contact_Organization: Montana Department of Natural Resources and Conservation
Contact_Person: Dan Rogers
Contact_Position: Stewardship Coordinator
Contact_Address:
Address_Type: mailing and physical address
Address: 2705 Spurgin Road
City: Missoula
State_or_Province: MT
Postal_Code: 59804
Country: USA
Contact_Voice_Telephone: 406-542-4326
Contact_Facsimile_Telephone: 406-542-4203
Contact_Electronic_Mail_Address: danrogers@mt.gov
Native_Data_Set_Environment: Microsoft Windows XP Version 5.1 (Build 2600) Service Pack 2; ESRI ArcCatalog 9.2.0.1324
Data_Quality_Information:
Lineage:
Process_Step:
Process_Description:
1. When processing layers with the tools available in the Spatial Analyst toolbar, set the proper extent, cell size, projection, and analysis mask in Options.
2. When using the Arc Toolbox set of Spatial Analyst tools, set the proper extent, projection, mask, cell size, etc. in Environments.
Process_Step:
Process_Description:
INPUT LAYER: Public Lands (and timber industry lands)
Layer name: pub_and_plum
Data type: raster
Location: \DNRC_SAP\BaseData\Stewardship_PublicLands\

The Public Lands layer (pub_and_plum) is not used as an input layer to the model, but is used as a mask to determine the extent of private lands. This layer is derived from the following source layers:

a) Excluded Private (i.e. timber industry lands)
Source Layers: PCTC_Parcels.shp and Non_PCTC_Industry_parcels.shp (provided by Dan Rogers of MT DNRC). These lands included Plum Creek Timber Company, Stimson Lumber Company, F. H. Stoltze Land & Lumber Company, and YT Timber company.
Data type: polygon
Location: \DNRC_SAP\BaseData\Stewardship_PublicLands\PrivateExclusions\

Convert the timber industry lands shapefiles to grids assigning industry lands equal to 1, and all other areas to NoData. Grids include pctc and other_tc.

b) Public Lands (from Information Technology Service Division (ITSD), Montana Department of Administration Stewardship geodatabase)
Source Layer: Publiclands
Data type: polygon - geodatabase feature class
Location: \DNRC_SAP\BaseData\Stewardship_PublicLands\Stewardship.mdb\ParcelFeatures

c) Public Lands and Plum Cr. Timber industry lands

These are the public and Plum Cr. Timber Co. lands selected from the Publiclands feature class.

Source Layer: stew_pandp
Data type: raster
Location: \DNRC_SAP\BaseData\ Stewardship_PublicLands\

Select and flag public lands polygons in the Publiclands feature class as per the following list:

AGENCY	OWN code	PublicCode
Unknown	0	0
US Government	10	1
US Bureau of Land Management	11	1
US Bureau of Reclamation	12	1
US Fish and Wildlife Service	13	1
National Park Service	14	1
US Forest Service	15	1
US Dept of Agriculture	16	1
US Army Corps of Engineers	17	1
US Dept of Defense	18	1
State of Montana	20	1
Montana State Trust Lands	21	1
Montana Fish, Wildlife, and Parks	22	1
Montana University System	23	1
Montana Dept of Corrections	24	1
Montana Dept of Transportation	25	1
Montana Dept of Natural Resources Water Projects	26	1
Local Government	30	1
County Government	31	1
City Government	32	1
Bureau of Indian Affairs Trust Land	40	0
Blackfeet Tribal Lands	41	0
Crow Tribal Lands	42	0
Salish and Kootenai Tribal Lands	43	0
Fort Belknap Tribal Lands	44	0
Fort Peck Tribal Lands	45	0
Northern Cheyenne Tribal Lands	46	0
Chippewa-Cree Tribal Lands	47	0
Turtle Mountain Alloted Lands	48	0
Private Land	50	0
Plum Creek Timber Company	52	1
Private Land Trusts	60	0
The Nature Conservancy	61	0
Montana Land Reliance	62	0
Rocky Mountain Elk Foundation	63	0
Ducks Unlimited	64	0
Boone and Crockett Club	65	0
Five Valleys Land Trust	66	0
Flathead Land Trust	67	0
Gallatin Valley Land Trust	68	0
Prickly Pear Land Trust	69	0
Bitter Root Land Trust	71	0
Blackfeet Land Trust	72	0
Mid-Yellowstone Land Trust	73	0
Water	81	1
Water - reserved/withdrawn by federal agency	81	1

Water - state trust land, state water project or state Fish, Wildlife, and Parks 82 1
Water - tribal 84 1
Water - private 85 1
Water - navigable (state Dept of Natural Resources) 88 1
Water - both state and federal claims 89 1

Convert the selected public lands polygons to a grid with cell value of 1 for areas of public lands, water, and Plum Cr. lands, and NoData for all other areas. Note: Plum Cr. timber industry lands are included with public lands.

d) Public Lands (from NRIS Stewardship layer)
Source Layer: ab105.shp
Data type: polygon
Location: \DNRC_SAP\BaseData\Stewardship_PublicLands\
Metadata: Metadata for Land Ownership and Managed Areas in Montana (ab105).htm
Note: The Montana NRIS stewardship layer (ab105.shp) was used to fill in where the stewardship Publiclands data is incomplete.

e) Public Lands and Plum Cr.
These are the public and Plum Cr. Timber Co. lands selected from the stewardship
shapefile, ab105.shp
Source Layer: ab105_pandp
Data type: raster
Location: \DNRC_SAP\BaseData\ Stewardship_PublicLands\

i. Select and flag public lands AND Plum Cr. Timber Co. polygons as per the list shown above for the Publiclands feature class. Convert selected polygons to a grid, public and timber industry lands = 1, other = 0.

ii. Combine source layers to create the public lands layer to be used for the proximity to public lands layer and as the mask for generating the private forest land layer. Since the DNRC forest stewardship program focuses on non-corporate forest lands, timber industry lands were included in the "public lands" layer. Layers containing public lands and Plum Cr. lands plus the additional timber industry lands layer provided by DNRC were combined. The layers were combined such that the DNRC timber industry lands took precedence, next were the selected areas from the stewardship Publiclands feature class, stew_pandp, and then the selected public and Plum Cr. polygons from the NRIS stewardship layer, ab105_pandp, were used to fill in any remaining gaps (i.e. pub_and_plum = pctc + other_tc + stew_pandp + ab105_pandp).

Process_Step:
Process_Description:
INPUT LAYER: Private Forestlands
Layer name: privatefor051
Data type: raster
Location: \DNRC_SAP\InputGrids\

The Private Forestlands layer is forest areas selected from the National Land Cover Database (NLCD) with public and large timber companies' lands masked out with the Public Lands layer (pub_and_plum).

a) NLCD
Source Layer: mt_nlcd
Data type: raster
Location: \DNRC_SAP\BaseData\NLCD\
Metadata: mt_nlcd.html

National Land Cover Database Classification:

Value	Land Cover Class
11	Open Water
12	Perennial Ice/Snow
21	Low Intensity Residential
22	High Intensity Residential
23	Commercial/Industrial/Transportation
31	Bare Rock/Sand/Clay
32	Quarries/Strip Mines/Gravel Pits
33	Transitional
41	Deciduous Forest
42	Evergreen Forest
43	Mixed Forest
51	Shrubland
61	Orchards/Vineyards/Other
71	Grasslands/Herbaceous
81	Pasture/Hay
82	Row Crops
83	Small Grains
84	Fallow
85	Urban/Recreational Grasses
91	Woody Wetlands
92	Emergent Herbaceous Wetlands

b) Reclassified NLCD
Source Layer: nlcd_for051
Data type: raster
Location: \DNRC_SAP\BaseData\NLCD\

Reclassify NLCD (mt_nlcd) with Spatial Analyst to make nlcd_for051. Reclassify values 41, 42, 43, and 91 to 1 and all other values to 0. Shrublands (value 51) were not included in the forest layer.

c) Public lands (as described above)
Source Layer: pub_and_plum
Data type: raster
Location: \DNRC_SAP\BaseData\Stewardship_PublicLands\

Mask NLCD forest with Public lands: The private forest layer is generated by masking out all NLCD forest lands, nlcd_for051, that are overlaid by areas of "public land" in the public lands layer, pub_and_plum.

Process_Step:
Process_Description:
INPUT LAYER: Forest patches
Layer name: forpatches051
Data type: raster
Location: \DNRC_SAP\InputGrids\

a) Roads
Source Layer: Road
Data type: line

Location:
\DNRC_SAP\BaseData\Transportation\TransportationAddressingFramework_1-6.mdb\TransportationFeatures
Metadata: View in ArcCatalog

b) Forest
Source Layer: nlcd_for051
Data type: raster
Location: \DNRC_SAP\BaseData\NLCD\

Note: Initial specifications called for roads to be buffered by type: 100 feet for interstates, 55 feet for state and federal highways, and 38 feet for all other roads. But, because the analysis layers will be either 30 meter or 90 meter cell grids, it is impossible to use the desired buffers. Buffering the linear roads and then creating grids from the buffer polygons, creates undesired breaks in the road corridor continuity. Also, it is impossible to exactly replicate 38 ft., 55 ft., or 100 ft. buffer polygons with 30 or 90 meter cells. However, creating a road grid, with 30 meter cell size, directly from the vector road features maintains continuity of road corridors and, more or less, approximates a buffer zone along the roads. The grid representation of a linear feature (i.e. roads) resulted in buffer zones ranging from about 0 to over 120 feet on one side of the linear element, but continuity was maintained when using the FOUR option with the regiongroup routine. Using FOUR prevented cells that only have adjacent corners from being assigned to the same group, so it did not connect forest patches on opposite sides of a road.

Road type is specified in the field, System (and also DisplayClass).

System-DisplayClass
NHS INTERSTATE-1
NHS NON-INTERSTATE-2
OFF SYSTEM-6
OTHER-8
PRIMARY-3
SECONDARY-4
URBAN-5
USFS-7

i. Generate the raster road layer using DisplayClass as the value field.
ii. Use the Arc Toolbox Expand tool with the road grid, and set the parameters as follows: Number of cells = 1, and Zone value = 1 (to expand the interstate road sections by one additional cell on either side.
iii. Use the expanded road grid as a mask to cut out the forest areas from the NLCD forest layer that fall within the road "buffer" zones. That is, areas that were classified as forest in NLCD that are in a road buffer area are set to non-forest.
iv. Use the REGIONGROUP function to assign unique IDs to contiguous groups of grid cells.
(Use the FOUR option in the REGIONGROUP function for connectivity because FOUR only connects adjacent cells that have coincident sides, EIGHT will also connect cells with adjacent corners which would connect forest patches on opposite sides of roads.)
v. Reclassify the groups by area. Forest patches equal to or greater than 100 acres are assigned a value of 1, and those less than 100 acres are set equal to 0 (i.e. not shown as forest). In order to use an

expression to reclassify the forest patches grid, the Arc Toolbox CON tool must be used.

vi. Parameters:
input condition (input grid): patch_groups
true: 1
false: 0
output grid: forpatches051
Expression: Value <> 0 AND Count >= 450*
* (450 cells of 30 meter cell size is approximately 100 acres.)

Process_Step:
Process_Description:
INPUT LAYER: Riparian Areas
Layer name: riparian
Data type: raster
Location: \DNRC_SAP\InputGrids\

a) NHD
Source Layer: nhd_drain.shp
Data type: line
Location: \DNRC_SAP\BaseData\Hydro\NHD\
Metadata: nhd_drain.html, fcode.html

b) NHD
Source Layer: nhd_lake.shp
Data type: polygon
Location: \DNRC_SAP\BaseData\Hydro\NHD\
Metadata: nhd_lake.html, & fcode.html

c) NHD selected
Source Layer: nhd_perennial&55800.shp
Data type: line
Location: \DNRC_SAP\BaseData\Hydro\NHD\

Select stream segments from nhd_drain.shp where FCODE = 46004 (description: Hydrographic Category|perennial; Positional Accuracy|definite) and FCODE = 55800 (description: feature type only: no attributes), and extract those stream segments to create the nhd_perennial&55800.shp layer.

Note: The 55800 stream segments are also used because some streams and rivers that are perennial (such as portions of the Clark Fork River) are not coded 46004. It appears that the stream segments that overlay polygons in the NHD_wb (water bodies) data set are for maintaining connectivity of the stream routes through those water bodies and are coded 55800. These water bodies include some sections of rivers that are shown as polygons in addition to lakes, therefore some sections of perennial streams and rivers are missing if only the 46004s are selected.

i. The "55800" stream segments in nhd_perennial&55800.shp stream layer that pass through lake and pond polygons of the nhd_lake.shp layer are selected, using the spatial select tool, and deleted from the perennial stream layer.
ii. The remaining perennial streams are buffered by 300ft.
iii. Convert the perennial stream buffer polygons to a grid with grid value = 1 for riparian corridors and 0 for non-riparian areas.

Note: Riparian classifications in the National Wetlands Inventory were available for a portion of Montana, but they were not used for riparian for the Montana SAP.

Process_Step:
Process_Description:
INPUT LAYER: Wetlands
Layer name: wetlands
Data type: raster
Location: \DNRC_SAP\InputGrids\

a) National Wetlands Inventory (NWI)
Source Layer: nwi_montana.shp
Data type: polygon
Location: \DNRC_SAP\BaseData\Wetlands\NWI\
Metadata: NWI.htm

i. Merged the available NWI 7.5 minute quadrangle map tiles into a state wide NWI layer (nwi_montana.shp).
ii. Added field Class, and attributed according to lookup table shown below as Wetland, Riparian, or blank.
iii. Convert NWI poly features to grid on Class as lookup field. Wetland areas were assigned a cell value of 2 and riparian was set to 3.

Note: the NWI is only available for a portion of Montana.

NWI classes:

ATTRIBUTE	CLASS
PSSA	Riparian
PSSB	Riparian
PSSC	Riparian
PUSA	Riparian
PUBG	Riparian
PUSC	Riparian
PEMB	Wetland
PEMA	Wetland
PEMC	Wetland
PABF	Wetland
PABG	Wetland
PEMF	Wetland
PFOA	Wetland
PFOB	Wetland
PFOC	Wetland
PEMH	Wetland
L1UBGh	Wetland
L1UBH	Wetland
L1UBHh	Wetland
L2ABFh	Wetland
L2ABG	Wetland
L2UBF	Wetland
L2USA	Wetland
L2USC	Wetland
L2USCh	Wetland
R2ABG	Wetland
R2UBF	Wetland
R2UBG	Wetland
R2UBH	Wetland
R2USA	Wetland

R2USC Wetland
R3RBH Wetland
R3UBF Wetland
R3UBG Wetland
R3UBH Wetland
R3USA Wetland
R3USC Wetland
R4SBC Wetland
R4SBF Wetland

See \DNRC SAP\BaseData\Wetlands\NWI\NWI_lookuptable.txt

b) NLCD
Source Layer: mt_nlcd
Data type: raster
Location: \DNRC_SAP\BaseData\NLCD\
Metadata: mt_nlcd.htm

Used NWI where available and filled in areas where it was not available with NLCD, Emergent Herbaceous Wetlands (value = 92).

Process_Step:
Process_Description:
INPUT LAYER: Slope
Layer name: pf_slope40
Data type: raster
Location: \DNRC_SAP\InputGrids\

a) DEM
Source Layer: mtdem30
Data type: raster
Location: \DNRC_SAP\BaseData\Topography\
Metadata: National Elevation Dataset for Montana.html

Generate percent slope grid from the 30 meter resolution DEM and then reclassify the slope grid to a value of 1 for areas with slope 0 to 40 percent, and 0 for areas with greater than 40 percent slope.

b) Private Forest Lands
Source Layer: privatefor051
Data type: raster
Location: \DNRC_SAP\InputGrids\

Use the private forest lands layer as a mask to select only slope values for the areas that fall within private forestlands, all other areas are given a slope value of 0.

Process_Step:
Process_Description:
INPUT LAYER: Proximity to Public lands
Layer name: prox2pub
Data type: raster
Location: \DNRC_SAP\InputGrids\

a) Public lands
Source Layer:: pub_and_plum
Data type: raster
Location: \DNRC_SAP\BaseData\Stewardship_PublicLands\

i. Use the Regiongroup routine to assign a unique ID to each contiguous group of cells in the pub_and_plum layer. Use the new public lands group layer and the zone layer to calculate the zonal stats of forest in public lands.

ii. Select the public lands groups in which 10 percent or more of the area overlays forest.

iii. Generate a distance-from grid for the public lands groups that contain 10 percent or more forest. Then reclassify so any grid cells within 800 meters (approximately ½ mile) of the selected public lands groups are coded 1 and all other areas are 0.

Process_Step:
Process_Description:
INPUT LAYER: Priority Watersheds
Layer name: priorityh2o6
Data type: raster
Location: \DNRC_SAP\InputGrids\

a) 6th-code hydrologic subbasins
Source Layer: HUC6th.shp (reprojected from huc12 polygon coverage)
Data type: polygon
Location: \DNRC_SAP\BaseData\Hydro\

b) TMDL 303(d) impaired or threatened waters
Source Layer: tmdlstr2004.shp (streams) & wb04cat.shp (lakes)
Data type: line and polygon
Location: \DNRC_SAP\BaseData\Hydro\305b\
Metadata: "Water Quality Integrated Report For Montana 2004" (2004_Overview.pdf) has information about the category ratings.

i. Select records from tmdlstr2004.shp and wb04cat.shp with SEGCOM values of 4 or 5. Use spatial select to select all 6th code HUC polygons that intersect any streams or lakes with a category 4 or 5 impaired waters classification.

ii. Convert the 6th code HUC polygon layer to a grid with the polygons containing TMDL category 4 or 5 impaired waters coded to 1 and unimpaired areas coded 0.

Process_Step:
Process_Description:
INPUT LAYER: Public Water Supply
Layer name: pws
Data type: raster
Location: \DNRC_SAP\InputGrids\

Public Water Supply Data Restrictions:
Release of this layer to the general public directly or through other agencies or entities is not authorized by DEQ.
Please refer to MetaSWP_PWS.doc for the full text on data restrictions.

a) Public Water Sources Locations
Source Layer: SW_PWSs.shp
Data type: point
Description: Spring, well, or surface water intake locations of public water supply systems, know as the Source Water Protection Database maintained by the Source Water Protection Program of the Montana DEQ.
Location: \DNRC_SAP\BaseData\PWSS\
Metadata: MetaSWP_PWS.doc

b) 5th-code hydrologic subbasins
Source Layer: HUC5th.shp
Data type: polygon
Location: \DNRC_SAP\BaseData\Hydro\

i. Select Class = 'C' (community water source), from SW_PWSs.shp.
ii. Use spatial select to select the 5th-code subbasins that contain one or more of the selected SW_PWSs.shp community water source points.
iii. Convert HUC5th polygon layer to a grid with a grid value of 1 for the selected subbasins and 0 for the remaining polygons.

Process_Step:
Process_Description:
INPUT LAYER: Threatened & Endangered Species
Layer name: t_and_e
Data type: raster
Location: \DNRC_SAP\InputGrids\

Threatened and Endangered Species Data Restrictions: The information provided by MTNHP is intended for distribution or use only within your department, agency, or business.
Refer to data agreement 060606 gsi.doc for the full text on data restrictions.

a) Montana threatened & endangered
Source Layer: mt_te.shp
Data type: polygon
Location: \DNRC_SAP\BaseData\T&E\
Metadata: eo_metadata.htm and SOC_Explain.pdf

Convert to grid where polygons containing T&E species are assigned a grid value of 1 and all other areas are 0.

Process_Step:
Process_Description:
INPUT LAYER: Forest Productivity
Layer name: forprod4cls
Data type: raster
Location: \DNRC_SAP\InputGrids\

a) UM/MT DOR Forest Productivity
Source Layer: ForestProductivity_sp83.shp
Data type: polygon
Location: \DNRC_SAP\BaseData\Forest\ForestProductivity\

Add integer field (SAP_CODE) to the UM forest productivity cover and classify polygons such that those with existing GridCodes (productivity classes) of -9999, 1, 2, 3, and 8 are given a SAP_CODE 0, and GridCodes 4, 5, 6, and 7 are reclassified to 3, 6, 12, and 13 respectively. Converted to grid based on SAP_CODE value.

Forest Productivity GridCode	Description	SAP_CODE
-9999	unknown	0
1	Non forest	0
2	Non commercial (hardwoods & riparian)	0
3	Commercial (5 - 15 acres)	0
4	25 - 45 cu ft/ac/yr	3
5	45 - 65 cu ft/ac/yr	6

6 65 - 85 cu ft/ac/yr 12
7 85+ cu ft/ac/yr 13
8 Water 0
Process_Step:
Process_Description:
INPUT LAYER: Wildfire Risk
Layer name: wildfire_pf
Data type: raster
Location: \DNRC_SAP\InputGrids\

a) LANDFIRE Rapid Assessment Fire Regime Condition Classes
Source Layer: wildfire
Data type: raster
Location: \DNRC_SAP\BaseData\USFS_R1\Landfire\
Metadata: LANDFIRE Rapid Assessment Fire Regime Condition Classes - metadata.htm

Reclassified LANDFIRE data. Fire regime condition classes II and III were assigned a grid value 1 and all other classes were set to 0.

FRCC_name	LANDFIRE Code	Wildfire value
01: FRCC 1	Fire Regime Condition Class I	0
02: FRCC 2	Fire Regime Condition Class II	1
03: FRCC 3	Fire Regime Condition Class III	1
04: Water	Water	0
05: Snow/Ice	Snow / Ice	0
06: Barren	Bare Rock / Sand / Clay	0
07: Developed	Urban/Transportation/Mines/Quarries	0
08: Agriculture	Agriculture	0
09: Non-Classified V	Wetlands / Alpine / Others	0
10: Unclassified	Unclassified / Unknown	0

2) Private forestland
Source Layer: privatefor051
Data type: raster
Location: \DNRC_SAP\InputGrids\

Mask areas not in private forest lands
Assign only areas within private forest lands a wildfire risk score, all other areas will have a wildfire value of 0.
Process_Step:
Process_Description:
INPUT LAYER: Forest Health (Insects & Disease)
Layer name: health2005ads
Data type: raster
Location: \DNRC_SAP\InputGrids\

a) Aerial Detection Survey
Source Layer: aerial_detection_survey_2005
Data type: polygon
Location: \DNRC_SAP\BaseData\USFS_R1\Insect&Disease\aerial_detection_srvy_r1_00_05.mdb\aerial_detection_srvy_r1_01_05
Metadata: aerial_detection_svry_r1_00_05.htm

i. Select polygons where one or more of the attributes, BUG1, BUG2, or BUG3, contain one of the following insect & disease codes:

Bug Code Description
1   Douglas-fir beetle
2   Engelmann spruce beetle
4   Mountain pine beetle (WP)
5   Mountain pine beetle (PP)
6   Mountain pine beetle (LPP)
7   Mountain pine beetle (WBP or Lim.)
9   Fir engraver
11 Western balsam bark beetle (SAF)
20 Spruce budworm, heavy defoliator
50 White pine blister rust
51 Dwarf mistletoe

ii. Convert to grid classifying the selected areas as 1 and all other areas as 0

Process_Step:
Process_Description:
INPUT LAYER: Development
Layer name: development
Data type: raster
Location: \DNRC_SAP\InputGrids\

a) Forecasted Residential Structures Per Quarter Section, STATUS QUO SCENARIO
Source Layer: statusquo2025.shp
Data exist for 31 central and western Montana counties: Beaverhead, Big Horn, Broadwater, Carbon, Cascade, Deer Lodge, Flathead, Gallatin, Glacier, Granite, Jefferson, Lake, Lewis and Clark, Liberty, Lincoln, Madison, Meagher, Mineral, Missoula, Park, Pondera, Powell, Ravalli, Sanders, Silver Bow, Stillwater, Sweet Grass, Teton, Toole, Treasure, and Yellowstone.
Data type: polygon
Location: \DNRC_SAP\BaseData\Development\
Metadata: statusquo2025.txt

Convert shapefile to a grid with areas forecasted to have greater than 5 homes per quarter section set equal to 1 and areas forecasted to have 5 or less homes or areas that were not analyzed are assigned a grid value of 0.

Process_Step:
Process_Description:
INPUT LAYER: Critical Private Lands Mask
Layer name: critplmask
Data type: raster
Location: \DNRC_SAP\InputGrids\

This is the private lands layer used to define the area of analysis in the stewardship potential model. It includes both forest and nonforest private lands. The areas masked or excluded from analysis by the model are public lands and industrial forest company lands, and also open water, quarries, bare rock and sand, perennial ice and snow, and industrial/urban areas as identified by NLCD (values = 11, 12, 21, 22, 23, 31, and 32).

a) NLCD
Source Layer: mt_nlcd
Data type: raster
Location: \DNRC_SAP\BaseData\NLCD\

Metadata: mt_nlcd.htm

b) Public Lands (and timber industry lands)
Source Layer: pub_and_plum
Data type: raster
Location: \DNRC_SAP\BaseData\Stewardship_PublicLands\

i. Generate water/urban mask by setting areas where NLCD = 11, 12, 21, 22, 23, 31, and 32 to NoData and all other areas are set to 1.
ii. Make public lands mask by setting all areas of public and timber industry lands to NoData.
iii. Combine water/urban mask with public lands mask to create Critical Private Forest Lands mask.

Process_Step:
Process_Description:
INPUT LAYER: Private Forestland Mask
Layer name: pfmask051
Data type: raster
Location: \DNRC_SAP\InputGrids\

This layer is identical to the Private Forestlands layer, privatefor051, except the cells with a value of 0 in that layer have been converted to NoData for the Private Forestland Mask. This limits map calculations or analysis routines to only those areas classified as Private Forestlands.

a) Private forestland
Source Layer: privatefor051
Data type: raster
Location: \DNRC_SAP\InputGrids\

Convert zero value cells to NoData.

Process_Step:
Process_Description:
INPUT LAYER: Nonforest Nondeveloped Mask
Layer name: nfnd_mask
Data type: raster
Location: \DNRC_SAP\InputGrids\

This is the mask used for calculations and modeling on nonforest and nondeveloped areas. It is the nonforest part of the Critical Private Lands Mask with developed areas also removed.

a) Critical Private Lands Mask
Source Layer: critplmask
Data type: raster
Location: \DNRC_SAP\InputGrids\

b) Private forestland
Source Layer: privatefor051
Data type: raster
Location: \DNRC_SAP\InputGrids\

c) Development
Source Layer: development
Data type: raster
Location: \DNRC_SAP\InputGrids\

Private forestland areas and developed areas are subtracted from the Critical Private Lands Mask.

Process_Step:

Process_Description:

INPUT LAYER: Forestland Ownership
Layer name: forestlandown
Data type: raster
Location: \DNRC_SAP\BaseData\Stewardship_Publiclands\

Ownership layer derived by combining the Plum Creek Timber Company, other large timber companies, ITSD Publiclands, and NRIS stewardship layers, i.e. pctc, other_tc, Publiclands, and ab105. The OWN code was used for the grid value, with the pctc areas set equal to 952, and the other_tc areas coded as 953. Ownership is shown only on forest lands as per the nlcd_for051 layer. The following categories were not included: unknown, local government, county government, city government, land trusts, and water. The forestland layer was used for the Forestland Ownership map (map 7) by theming on the grid value. Owners were grouped into five categories - Federal, State, Tribal, Nonindustrial Private Forest (NIPF), and Industry. See \DNRC_SAP\Toolbox\forestland ownership.jpg and \DNRC_SAP\Toolbox\owner_for_graph.xls

AGENCY	Forestland Ownership
Unknown	NA
US Government	Federal
US Bureau of Land Management	Federal
US Bureau of Reclamation	Federal
US Fish and Wildlife Service	Federal
National Park Service	Federal
US Forest Service	Federal
US Dept of Agriculture	Federal
US Army Corps of Engineers	Federal
US Dept of Defense	Federal
State of Montana	State
Montana State Trust Lands	State
Montana Fish, Wildlife, and Parks	State
Montana University System	State
Montana Dept of Corrections	State
Montana Dept of Transportation	State
Montana Dept of Natural Resources Water Projects	State
Local Government	NA
County Government	NA
City Government	NA
Bureau of Indian Affairs Trust Land	Tribal
Blackfeet Tribal Lands	Tribal
Crow Tribal Lands	Tribal
Salish and Kootenai Tribal Lands	Tribal
Fort Belknap Tribal Lands	Tribal
Fort Peck Tribal Lands	Tribal
Northern Cheyenne Tribal Lands	Tribal
Chippewa-Cree Tribal Lands	Tribal
Turtle Mountain Alloted Lands	Tribal
Private Land (non-industrial)	NIPF
Private Land (other timber companies)	Industry
Plum Creek Timber Company	Industry
Private Land Trusts	NA

The Nature Conservancy NA
Montana Land Reliance NA
Rocky Mountain Elk Foundation NA
Ducks Unlimited NA
Boone and Crockett Club NA
Five Valleys Land Trust NA
Flathead Land Trust NA
Gallatin Valley Land Trust NA
Prickly Pear Land Trust NA
Bitter Root Land Trust NA
Blackfeet Land Trust NA
Mid-Yellowstone Land Trust NA
Water NA
Water - reserved/withdrawn by federal agency NA
Water - state trust land, state water project or state Fish, Wildlife, and Parks NA
Water - tribal NA
Water - private NA
Water - navigable (state Dept of Natural Resources) NA
Water - both state and federal claims NA

Process_Step:
Process_Description:
INPUT LAYER: Existing Stewardship Plans

DNRC provided township, range and section descriptions for private properties with forest stewardship plans in two databases and two ArcView shapefiles, containing a total of 1228 owner records. There were 33 records with no township, range and section and one record with an incorrect township, range and section that could not be used. The remaining township, range and section descriptions were used as provided by DNRC.

i. Combine databases from DNRC

a) Source Layer: legaldescriptions82106
Data type: database
Location: \DNRC_SAP\BaseData\Existing_Plan_Areas\SAP legal descriptions.mdb

b) Source Layer: Teigen2_Union.shp
Data type: polygon
Location: \DNRC_SAP\BaseData\Existing_Plan_Areas\

c) Source Layer: SiebenUnionALL.shp
Data type: polygon
Location: \DNRC_SAP\BaseData\Existing_Plan_Areas\

d) Source Layer: LEGALS_101306.xls
Data type: spreadsheet
Location: \DNRC_SAP\BaseData\Existing_Plan_Areas\

ii. Add unique identification number for each owner
See "ID" in legaldescriptions82106
See "Owner_ID" in Teigen2_Union.shp (owner_id #1713 only)
See "Owner_ID" in SiebenUnionALL.shp (owner_id #1908 only)
See "Owner_ID" in LEGALS_101306.xls (owner_id #1290 & #1871 only)

iii. Standardize township, range, and section for each record

iv. Create record for each unique township, range, and section combination

v. Divide the total listed acreage for each owner by the total number of sections to determine the average acres per section

vi. Join the resulting database to the public land survey shape file
Source Layer: mtplsssp
Data type: polygon
Location: \DNRC_SAP\BaseData\Existing_Plan_Areas\

vii. Extract the selected sections selected to create a layer with apportioned stewardship planning acres based on the reported values in the database tables maintained by DNRC. The section layer included:
a. a unique identification number for each owner in that section (with up to five owners in some sections): Owner1, Owner2, etc.
b. the average acres per owner: Avg_Acr_01, Avg_Acr_02, etc.
c. the total average acres of all owners in each section: TotAvgAcr

The final steps in summarizing the stewardship priority for each plan were to overlay the apportioned section map on each of the final stewardship analysis layers and report the acres of each plan in high, medium and low categories
Layer name: sap_sections2
Data type: polygon
Location: \DNRC_SAP\BaseData\Existing_Plan_Areas\

i. Merge the Private Forestlands (PF) mask and the Non-Forestlands & Non-Developed lands (NFND) mask into one layer: pf_nfnd_mask
ii. Use Spatial Analyst Zonal Tool, Tabulate Area, to sum the area of PF and NFND within each SAP section. This generated a database file with a record for each SAP section and the area (in map units) of PF and/or NFND in that section (pf_nfnd_area_per_sapsect.dbf).
iii. Add three new fields to the database:
a) total area
b) fractional part of PF of the total for each section
c) fractional part of NFND of the total for each section
iv. Add the areas of PF and NFND for each section to populate the Total attribute.
v. Calculate the fractional part of PF and NFND, e.g. Percent_PF = Total/Area_PF (note - the "Percent" values are fractions).
vi. Multiply the TotAvgAcr by the fractional value for PF and NFND to get the acreage of PF and NFND in each SAP section.
vii. Add fields to the attribute table of the SAP sections shapefile:
a) Percent_PF
b) Percent_NF
c) PF_TotAc
d) NFND_TotAc
viii. Join the pf_nfnd_area_per_sapsect.dbf table to the SAP sections attribute table and populate the added fields from the corresponding fields in the joined table.
ix. Use Spatial Analyst Zonal Tool, Zonal Statistics as Table, to find the majority value of the stewardship potential rank for just the PF areas, then just the NFND areas, and finally for the overall critical private lands (CPL) in each SAP section.

x. Join the stats tables to the SAP sections attribute table.
xi. Add fields to the SAP section attribute table and then populate with the values from the joined majority tables.
a) PF_ major
b) NFND_ major
c) CPFL_major
xii. Summarize the acreage of High, Med, and Low stewardship potential for each category of critical private lands:
a) Critical private forestlands (PF)
b) Critical non-forestlands & non-developed lands (NFND)
c) Critical private lands (CPL)

Process_Step:
Process_Description:
MODEL OUTPUT LAYER: Stewardship Potential
Layer name: fsp_cpl
Data type: raster
Location: \DNRC_SAP\ModelOutput\
Metadata: metadata.xml

This grid is the result of the Forest Stewardship Potential Analysis overlay model (the SAP_model in the SAP ArcToolbox). The cell values of fsp_cpl are the combined scores from all of the resource richness and resource threats layers. Each input layer, with the exception of the forest productivity layer, forprod4cls, is a binary grid with values of 1 or 0 identifying presence or absence of that particular forest resource or threat. Each richness and threat layer was assigned a score based on its relative influence on assessment of forest management potential. The input layers in the model were multiplied by their assigned score and then the weighted layers were added on a cell-by-cell basis to create the Classified Forest Stewardship Potential on Critical Private Lands layer: fsp_cpl.
See \DNRC_SAP\Toolbox\SAP.tbx
See \DNRC_SAP\Toolbox\SAP_Model.jpg
See \DNRC_SAP\Toolbox\SAP_Tool.htm
See \DNRC_SAP\Toolbox\ SAP_Tool.xml
See \DNRC_SAP\Toolbox\ SAP_Tool_report.xml

Forest Stewardship Potential data layers:

Data Theme	Weighting Factor
Private Forestland	15
Forest Productivity	3, 6, 12, 13*
Forest Health	11
Wildfire Risk	11
Development	8
Proximity to Public Lands	8
Forest Patches	7
Priority Watersheds	7
Riparian River Areas	6
Public Water Supply	5
Threatened & Endangered Species	3
Slope	3
Wetlands	3

* These are the productivity values already assigned for this layer, no other weighting factor is applied. See previous description for Forest Productivity.

Process_Step:

Process_Description:
MODEL OUTPUT LAYER: Classified Forest Stewardship Potential on Critical Private Lands
Layer name: cfsp_cpl
Data type: raster
Location: \DNRC_SAP\ModelOutput\
Metadata: metadata.xml

This is the Classified Forest Stewardship Potential on Critical Private Lands
layer (fsp_cpl) classified into three categories of potential stewardship - High, Med, & Low. The classification breaks were determined by the model input scoring matrix and thresholds set by the SAP subcommittee of the MFSSC committee, using the following rules:

The classification was derived from the final value for the sum of grid layers used in the "Classified forest stewardship potential on critical private lands" layer (grid cells in a 30 meter x 30 meter unit of analysis)

High - Those that had a value greater than or equal to 39, the sum of the highest three map layers scores (39-91)
Medium - Those that had a value less than 39, the sum of the highest three map layers scores AND had a score greater than 32, the sum of the remaining layers not in the top 3, but with forest related influence in the model (33-38)
Low - Those that had a value less than or equal to 32, with no forest related influence in the model (1-32)

Source Layer name: fsp_cpl
Data type: raster
Location: \DNRC_SAP\ModelOutput\
Metadata: metadata.xml
Process_Step:
Process_Description:
MODEL OUTPUT LAYER: Classified Forest Stewardship Potential on Critical Private Forestlands
Layer name: cfsp_pf
Data type: raster
Location: \DNRC_SAP\ModelOutput\
Metadata: metadata.xml

This is the same stewardship potential classifications as cfsp_cpl, but limited to private forestland areas as defined by the Private Forestland layer, privatefor051.

Source Layer name: cfsp_cpl
Data type: raster
Location: \DNRC_SAP\ModelOutput\
Metadata: metadata.xml
Process_Step:
Process_Description:
MODEL OUTPUT LAYER: Classified Forest Stewardship Potential on Critical Private Non-forestlands & Non-developed Lands
Layer name: cfsp_cpnf
Data type: raster
Location: \DNRC_SAP\ModelOutput\
Metadata: metadata.xml

This layer was also extracted from the classified Classified Forest Stewardship Potential on Critical Private Lands layer, cfsp_cpl, for areas designated as non-forestlands and non-developed. It is the inverse of the private forestlands layer with areas of development, as determined by the development layer, also removed.

Source Layer name: fsp_cpl
Data type: raster
Location: \DNRC_SAP\ModelOutput\
Metadata: metadata.xml

Process_Step:
Process_Description:
MODEL OUTPUT LAYER: Resource Richness
Layer name: res_richness
Data type: raster
Location: \DNRC_SAP\ModelOutput\
Metadata: metadata.xml

This grid is the final output of the SAP Resource Richness model. A subset of the data themes comprising the Forest Stewardship Potential Analysis model (SAP_model) were added together on a cell-by-cell basis to derive a richness score. The logic for weighting factors used in the SAP_model could not be used for the resource richness, since the total list of layers was separated into two categories. Therefore the Jenks method or "Natural Breaks" classification method in the ESRI ArcView software was used to derive the resource richness categories of High, Med, or Low. The natural breaks thresholds divide the classification into:
High (30-66)
Medium (14-29)
Low (3-13)

See \DNRC_SAP\Toolbox\Resource_Richness_tool.htm
See \DNRC_SAP\Toolbox\Resource_Richness_tool.jpg
See \DNRC_SAP\Toolbox\Resource_Richness_tool.xml
See \DNRC_SAP\Toolbox\Resource_Richness_tool_report.xml

The same data layers were used as for the Forest Stewardship Potential model with the exception of Forest Health, Wildfire Risk, and Development.

The unclassified grid is also included.
Source Layer name: richness
Data type: raster
Location: \DNRC_SAP\ModelOutput\

Process_Step:
Process_Description:
MODEL OUTPUT LAYER: Resource Threats
Layer name: res_threats
Data type: raster
Location: \DNRC_SAP\ModelOutput\
Metadata: metadata.xml

Like the Resource Richness model, this is a subset of the Forest Stewardship Potential model. The logic for weighting factors used in the SAP_model could not be used for the resource threats, since the total list of layers was separated into two categories. Therefore the Jenks method or

"Natural Breaks" classification method in the ESRI ArcView software was used to derive the resource threats categories of High, Med, or Low. The natural breaks thresholds divide the classification into:

High (12-30)
Medium (9-11)
Low (8)

See \DNRC_SAP\Toolbox\Resource_Threats_tool.htm
See \DNRC_SAP\Toolbox\Resource_ Threats _tool.jpg
See \DNRC_SAP\Toolbox\Resource_ Threats _tool.xml
See \DNRC_SAP\Toolbox\Resource_ Threats _tool_report.xml

The resource threat layers are Forest Health, Wildfire Risk, and Development.
The unclassified grid is also included.
Source Layer name: threats
Data type: raster
Location: \DNRC_SAP\ModelOutput\

```
Spatial_Data_Organization_Information:
  Direct_Spatial_Reference_Method: Raster
  Raster_Object_Information:
    Raster_Object_Type: Grid Cell
    Row_Count: 17696
    Column_Count: 30638
    Vertical_Count: 1
Spatial_Reference_Information:
  Horizontal_Coordinate_System_Definition:
    Planar:
      Grid_Coordinate_System:
        Grid_Coordinate_System_Name: State Plane Coordinate System 1983
        State_Plane_Coordinate_System:
          SPCS_Zone_Identifier: 2500
          Lambert_Conformal_Conic:
            Standard_Parallel: 45.000000
            Standard_Parallel: 49.000000
            Longitude_of_Central_Meridian: -109.500000
            Latitude_of_Projection_Origin: 44.250000
            False_Easting: 600000.000000
            False_Northing: 0.000000
      Planar_Coordinate_Information:
        Planar_Coordinate_Encoding_Method: row and column
        Coordinate_Representation:
          Abscissa_Resolution: 30.000000
          Ordinate_Resolution: 30.000000
        Planar_Distance_Units: meters
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      Horizontal_Datum_Name: North American Datum of 1983
      Ellipsoid_Name: Geodetic Reference System 80
      Semi-major_Axis: 6378137.000000
      Denominator_of_Flattening_Ratio: 298.257222
Entity_and_Attribute_Information:
  Detailed_Description:
    Entity_Type:
      Entity_Type_Label: fsp_cpl.vat
    Attribute:
      Attribute_Label: Rowid
      Attribute_Definition: Internal feature number.
```

```
      Attribute_Definition_Source: ESRI
      Attribute_Domain_Values:
        Unrepresentable_Domain: Sequential unique whole numbers that are
automatically generated.
    Attribute:
      Attribute_Label: VALUE
    Attribute:
      Attribute_Label: COUNT
Distribution_Information:
  Distributor:
    Contact_Information:
      Contact_Organization_Primary:
        Contact_Organization: Montana Department of Natural Resources and
Conservation
        Contact_Person: Dan Rogers
      Contact_Position: Stewardship Coordinator
      Contact_Address:
        Address_Type: mailing and physical address
        Address: 2705 Spurgin Road
        City: Missoula
        State_or_Province: MT
        Postal_Code: 59804
        Country: USA
      Contact_Voice_Telephone: 406-542-4326
      Contact_Facsimile_Telephone: 406-542-4203
      Contact_Electronic_Mail_Address: danrogers@mt.gov
  Resource_Description: Downloadable Data
  Standard_Order_Process:
    Digital_Form:
      Digital_Transfer_Information:
        Transfer_Size: 76.564
Metadata_Reference_Information:
  Metadata_Date: 20061221
  Metadata_Contact:
    Contact_Information:
      Contact_Organization_Primary:
        Contact_Organization: Montana Department of Natural Resources and
Conservation
        Contact_Person: Dan Rogers
      Contact_Position: Stewardship Coordinator
      Contact_Address:
        Address_Type: mailing and physical address
        Address: 2705 Spurgin Road
        City: Missoula
        State_or_Province: MT
        Postal_Code: 59804
        Country: USA
      Contact_Voice_Telephone: 406-542-4326
      Contact_Facsimile_Telephone: 406-542-4203
      Contact_Electronic_Mail_Address: danrogers@mt.gov
  Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial
Metadata
  Metadata_Standard_Version: FGDC-STD-001-1998
  Metadata_Time_Convention: local time
  Metadata_Extensions:
    Online_Linkage: http://www.esri.com/metadata/esriprof80.html
    Profile_Name: ESRI Metadata Profile
```